FIG. 1.—HOME OF BRICK MASON. DIETARY STUDY NO. 648.

Bulletin

United States. Office of Experiment Stations

1204 Issued December 23, 1909.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN 221.

A. C. TRUE, Director.

DIETARY STUDIES IN RURAL REGIONS

IN VERMONT, TENNESSEE, AND GEORGIA.

BY

J. L. HILLS, Sc. D.,
Director Vermont Experiment Station,

CHARLES E. WAIT, Ph. D., F. C. S.,
Professor of Chemistry, University of Tennessee,

H. C. WHITE, Ph. D.,
Professor of Chemistry, University of Georgia.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, D. Sc., Director.
E. W. ALLEN, Ph. D., Assistant Director and Editor of Experiment Station Record.
C. F. LANGWORTHY, Ph. D., Chief of Nutrition Investigations.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., September 4, 1909.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 221 of this Office, a report of four dietary studies in farmers' families in Vermont, carried on by J. L. Hills, sixty-four dietary studies in mountain regions in Tennessee, by C. E. Wait, and fourteen dietary studies in Georgia, most of them in rural regions, by H. C. White.

These investigations, like others of similar character previously reported, were undertaken to secure data regarding the food consumption and living conditions of families in different circumstances and surroundings. Information of this character is useful in formulating dietary standards and is of decided value in discussing a great variety of questions which pertain to the utilization as food of agricultural food products, both animal and vegetable.

Acknowledgment should be made to Prof. A. F. Gilman, of Maryville, Tenn., who in cooperation with Professor Wait collected the statistics in the Tennessee dietaries, to Prof. C. O. Hill, of the University of Tennessee, who has rendered great service in the analytical work, as well as in conducting the dietaries, and to Prof. C. M. Snelling and Messrs. S. S. Deane, W. M. Hardy, and J. G. Smith, of the University of Georgia, who assisted in collecting data or in the analytical work of the dietary studies carried on in Georgia, and to Doctor de Buboeay, of Tallulah Falls, Ga., whose long residence among the mountain people enabled him to secure their confidence and cooperation in the nutrition studies.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

DIETARY STUDIES IN RURAL REGIONS.

DIETARY STUDIES IN VERMONT FARMERS' FAMILIES.

By J. L. Hills, Sc. D.,
Director of Vermont Experiment Station.

INTRODUCTION.

Conditions vary so widely in different sections of the United States that it would be difficult to make a definite comparison between the dietary habits of the country as a whole and those of other parts of the world. The studies in this bulletin were planned to give definite information regarding actual diets in typical families of various rural sections. They have already proved of value in the preparation of a report on "Diet in Rural Regions" presented by the Office of Experiment Stations to President Roosevelt's Commission on Country Life. In that report a general survey was made of dietary conditions in rural regions, with especial reference to their importance in the question of home making. It was there stated that the United States has no such general problem of undernutrition as now causes anxiety in some nations of the Old World. There are, however, regions where dietary conditions could be readily improved with available resources, and many nutrition problems are as yet unsolved; obviously a thorough knowledge of dietary conditions must precede any systematic efforts for improvement.

The four following dietary studies were made by the Vermont Experiment Station in cooperation with the Office of Experiment Stations. The first one was made in Burlington, the others on farms believed to be typical of the region round about. The methods employed were the same as those used in studies previously reported by this Office.[a] The usual inventory was made of the kind and quantity of all food materials on hand at the beginning and end of each study and those entering the kitchen during its course, and their cost was also noted. All kitchen and table wastes were collected and carefully weighed, samples of almost all being preserved for analysis.

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 149, 150, 152, and other bulletins listed in Circ. 89.

CHARACTER AND COST OF FOOD MATERIALS.

The food materials used in the studies in farmers' families were to a large extent home grown. Part of the beef, the tropical fruits, dry and canned groceries, and butter were practically the only ones purchased. In the Burlington study the meats, with the exception of the pork, were from the West, but the milk and other farm products were mainly from neighboring farms. The butter was in all cases obtained from local dairies.

In estimating the cost of food in these studies, the price prevailing in the nearest market at the time of the study was used for the home-grown materials. This, of course, gives a cost far above the actual outlay and probably considerably above the real cost, could the expenditure of labor, material, etc., in producing the various articles be measured. This discrepancy seems unavoidable, and it must be borne in mind in considering the economy of the farm dietaries.

COMPOSITION OF FOOD MATERIALS.

Samples of the majority of the food materials used were analyzed according to the usual methods, and the results obtained were used in computing the nutrients and energy of the diets. The analyses represent only the edible portions, and are given in the following table:

Composition of food materials (edible portion) and waste analyzed in dietary studies Nos. 600 to 603.

Reference No.	Description of food material.	Water.	Nutrients.			
			Protein.	Fat.	Carbohydrates.	Ash.
	ANIMAL FOOD.					
	Beef:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18	Corned, cooked	44.54	24.61	26.33	....	3.76
20	Dried	61.85	25.60	2.35	....	9.75
21	Do	30.00	47.82	6.47	....	13.04
17	Heart, cooked	60.30	32.17	5.99	....	1.60
14	Roast, raw	67.54	20.41	11.00	....	1.29
15	Roast, cooked	52.11	28.57	18.48	....	1.35
1	Steak, rump, medium fat	64.58	20.92	13.09	....	1.26
2	Steak, round, lean	70.08	20.50	8.15	....	1.28
4	Steak, round, very lean	80.61	16.62	1.96	....	.82
5	Do	76.67	20.29	1.90	....	1.06
5a	Average Nos. 4 and 5	73.38	18.46	1.93	....	.94
3	Steak, sirloin, medium fat	65.34	19.47	14.36	....	1.59
6	Steak	62.61	21.58	11.68	....	1.42
7	Do	66.30	26.17	6.23	....	1.13
8	Do	64.35	21.89	12.62	....	1.37
9	Do	69.33	21.78	7.87	....	1.23
9a	Average Nos. 6, 7, 8, and 9	65.65	23.61	9.60	....	1.29
10	Steak, cooked	43.29	35.66	19.70	....	2.32
11	Do	68.32	23.98	6.64	....	1.37
11a	Average Nos. 10 and 11	55.81	29.82	13.17	....	1.85
12	Steak, cooked	48.80	27.38	21.10	....	2.90
13	Steak, Hamburg	70.13	22.77	6.26	....	1.44
16	Stew	72.91	19.84	6.17	....	1.13

Composition of food materials (edible portion) and waste analyzed in dietary studies Nos. 600 to 603—Continued.

Reference No.	Description of food material.	Water.	Nutrients.			
			Protein.	Fat.	Carbohydrates.	Ash.
	ANIMAL FOOD—continued.					
	Lamb:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
26	Chops (very young lamb), cooked	65.49	23.27	10.87	....	1.57
24	Forequarter, boned, very fat, cooked	46.32	20.14	32.27	....	1.02
25	Hindquarter (very young lamb)	50.42	42.67	4.79	....	2.27
	Pork:					
30	Bacon	30.47	17.20	45.38	....	6.70
27	Ham	51.75	24.13	16.88	....	6.95
28	Sausage, home-made	42.21	14.45	40.00	....	2.16
29	Do	38.38	15.65	42.32	....	3.25
	Poultry:					
31	Chicken, boned, fricasseed	79.40	17.10	3.00	....	.50
32	Chicken, boned, steamed	57.74	34.74	6.35	....	1.00
	Fish:					
33	Cod, salt	53.29	28.41	.71	....	19.69
34	Salmon, salt, pickled	53.60	21.47	7.30	....	16.48
35	Do	50.47	20.01	5.88	....	22.96
36	Eggs, hens'	75.50	12.65	9.75	....	1.09
37	Do	75.18	12.45	10.26	....	1.10
38	Do	75.37	13.90	9.39	....	.95
38a	Average Nos. 36, 37, and 38	75.35	13.00	9.80	....	1.05
	Dairy products:					
39	Cheese, cottage or Dutch	75.69	10.14	6.89	5.90	1.38
44	Cream, separator	74.30	3.00	17.50	4.50	.70
45	Do	72.60	2.60	19.30	4.80	.70
40	Milk, whole, grade Jersey	86.20	3.50	4.70	4.90	.70
41	Milk, whole, mainly grade Jersey	86.30	3.30	4.80	4.90	.70
42	Milk, whole, grade cows	88.10	2.90	3.40	4.90	.70
43	Milk, whole, mainly grade Jersey	86.70	3.30	4.60	4.70	.70
46	Milk, skim, separator	90.20	3.50	.40	5.20	.70
	VEGETABLE FOOD.					
	Cereals:					
65	Malt oats	8.33	15.87	5.00	69.18	1.62
66	Oatmeal	9.33	13.94	6.40	68.36	1.97
67	Do	9.12	16.03	6.65	62.63	5.57
68	Oats, rolled	8.00	18.00	6.95	64.70	2.35
69	Wheat breakfast food	11.55	12.94	.90	73.96	.65
70	Do	10.25	12.92	1.00	75.08	.75
82	Rice	13.06	10.27	.65	75.18	.84
83	Do	12.47	8.00	.33	78.52	.68
84	Do	11.63	7.69	.35	79.55	.78
53	Corn meal	10.52	7.00	1.60	80.19	.69
54	Do	11.92	8.94	1.10	77.26	.78
55	Do	12.12	9.31	3.68	73.31	1.58
56	Do	13.10	10.94	4.20	70.03	1.73
47	Flour, wheat bread	11.10	13.30	.98	73.87	.75
48	Do	12.52	10.81	.80	74.99	.88
49	Do	12.02	10.35	.72	76.18	.74
50	Do	12.35	10.28	.93	75.74	.70
51	Flour, wheat, pastry	11.70	10.43	1.08	76.15	.64
52	Do	11.96	9.62	.95	76.72	.75
57	Flour, wheat, graham	10.05	15.39	2.84	70.04	1.68
58	Do	11.40	16.80	2.78	66.97	2.05
59	Do	11.57	12.06	1.95	72.72	1.70
60	Flour, rye	11.16	13.91	1.93	72.09	.91
61	Bread, bakers'	34.49	10.70	1.02	52.58	1.21
62	Bread, home-made	33.46	8.86	.55	56.00	1.13
63	Do	30.08	9.48	1.59	57.51	1.34
64	Do	35.91	7.82	.89	53.67	1.71
77	Biscuit, baking powder	36.69	7.47	2.68	50.68	2.48
76a	Cake	....	5.50	7.40	59.10	....
76	Cookies, caraway seed	7.08	8.64	9.38	73.08	1.82
71	Crackers	8.00	9.80	11.41	68.90	1.89
72	Do	8.55	9.87	12.08	67.43	2.07
73	Doughnuts	18.53	6.12	27.56	46.76	1.03
74	Do	26.05	7.96	9.38	55.35	1.26
75	Ginger snaps	11.02	6.65	7.40	72.22	2.71
78	Johnnycake	55.32	5.81	2.11	33.95	2.81
78a	Pie crust	....	10.70	1.10	52.60	....
81	Sugars and starches: Tapioca	12.10	.52	.23	86.25	.90
	Vegetables:					
85	Beans, for baking	14.46	21.94	1.60	58.47	3.53
86	Do	13.17	22.00	1.76	58.32	4.75
87	Do	11.40	21.75	1.08	61.02	4.75
88	Do	12.53	21.82	1.60	59.65	4.40
89	Beets, pickled	84.22	2.83	.13	11.40	1.42

Composition of food materials (edible portion) and waste analyzed in dietary studies Nos. 600 to 603—Continued.

Reference No.	Description of food material.	Water.	Nutrients. Protein.	Fat.	Carbohydrates.	Ash.
	VEGETABLE FOOD—continued.					
	Vegetables—Continued.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
90	Corn, kernels, cooked	88.02	3.04	0.44	7.81	0.69
91	Do	77.35	4.23	.90	16.70	.82
91a	Average Nos. 90 and 91	82.69	3.64	.67	12.26	.76
92	Corn, kernels, cooked	62.65	4.44	1.43	30.50	.98
94	Mushrooms (average)	91.10	3.80	.30	3.20	1.60
95	Onions	89.21	.67	.10	9.55	.47
96	Peas, canned	81.61	5.13	.67	11.64	.95
97	Peas, green	75.13	6.79	2.99	13.60	1.39
98	Potatoes, peeled, cooked	77.28	2.91	.07	18.72	1.02
99	Do	77.13	3.09	.37	18.19	1.22
101	Do	80.49	1.89	.23	16.18	1.21
102	Do	79.41	2.50	.12	18.80	1.17
100	Potatoes, new, raw	83.44	2.17	.06	13.37	.96
106	Pumpkin, dried	25.24	6.59	.43	62.91	4.83
103	Radishes	96.33	.91	.07	1.92	.77
104	Horseradish tops	86.15	3.92	.46	8.26	1.21
117	Rhubarb	95.06	.59	.06	3.48	.81
105	Succotash	72.92	5.31	1.15	18.99	1.63
107	Tomatoes, canned	94.98	1.10	.35	2.95	.62
108	Turnips, cooked	87.88	1.31	4.13	4.57	2.11
	Fruits:					
109	Apples	93.21	.31	.13	6.05	.30
110	Apples, prepared for cooking	91.75	.28	.09	7.63	.24
111	Apple sauce	82.94	.33	.12	16.41	.20
112	Do	89.87	.33	.12	9.38	.30
113	Blackberries	82.94	1.55	.45	14.50	.56
114	Blueberries	85.19	.99	.72	12.78	.32
115	Currants, red	90.52	1.24	.84	6.71	.69
116	Raisins	23.96	2.43	.11	71.22	2.28
118	Rhubarb preserve	90.39	.79	.09	8.03	.70
119	Strawberries	92.70	.82	.23	5.74	.51
	MISCELLANEOUS FOODS.					
19	Beef pie with crust	54.57	24.57	12.05	6.62	2.19
22	Dried beef cooked with milk	81.11	5.79	5.41	5.82	1.87
23	Do	75.34	7.12	8.45	6.91	2.18
79	Cake	26.74	5.54	7.43	59.10	1.19
80	Blueberry pudding	55.90	5.45	2.37	35.15	1.13
	WASTE.					
120	Meat waste	45.30	16.46	34.89	.79	2.56
121	Do	47.25	14.02	27.32	8.63	2.80
122	Do	57.70	18.40	18.24	2.70	2.97
122a	Average Nos. 121 and 122	52.48	16.21	22.78	5.67	2.89
123	Meat waste	33.22	34.85	30.68	....	3.51
124	Do	43.91	21.10	7.37	25.12	2.50
125	Cereal waste	51.05	5.58	8.80	33.57	1.00
126	Do	43.25	7.68	5.25	41.24	2.58
127	Do	45.68	6.58	7.25	38.40	2.09
127a	Average Nos. 126 and 127	44.47	7.13	6.25	39.82	2.34
128	Cereal waste	17.26	10.83	4.26	64.39	3.26
129	Do	16.64	10.25	6.03	64.83	2.25
129a	Average Nos. 128 and 129	16.95	10.54	5.15	64.61	2.76
130	Cereal waste	44.97	6.73	4.58	41.02	2.70
131	Vegetable waste	76.56	2.95	3.30	16.02	1.17
132	Do	87.54	2.22	2.26	7.02	.98
133	Do	75.87	3.78	3.08	15.63	1.65
133a	Average Nos. 132 and 133	81.71	3.00	2.67	11.33	1.32
134	Vegetable waste	81.37	3.44	1.14	12.22	1.83
135	Do	74.36	4.59	1.48	17.17	2.40
135a	Average Nos. 134 and 135	77.87	4.02	1.31	14.70	2.12
136	Vegetable waste	72.89	3.40	2.67	19.34	1.70

In a few cases it was found impracticable or unnecessary to make special analyses of the materials used in these studies, and it was assumed that their composition was that of the average American products of similar nature, as given in an earlier bulletin [a] of this Office.

DETAILS OF THE STUDIES.

The detailed results of the four studies are given in the following sections. In the table accompanying each discussion the weight and cost of the various materials used during the entire study are shown in the left-hand column; the figures in parentheses following each item refer, in the case of foods which were analyzed in connection with the studies, to the table of composition (p. 8), where they may be found at the extreme left. In the case of foods which were not analyzed as a part of the investigation (Nos. 137–176) these figures refer to manuscript tables of assumed composition filed in this Office. In computing the amount and cost of nutrients consumed per man per day, as given in the last five columns, the usual assumptions were made regarding relative amounts of food consumed by persons of different age and sex, the make-up of the family being reported for each study.

DIETARY STUDY No. 600.

This study was made in the family of an officer of the Vermont Experiment Station, and was continued for ten days during the latter part of May, 1901. The family consisted of a college professor, his wife, two children, and a servant. A dressmaker and a house cleaner were present at a few meals. The number of meals served was as follows:

	Meals.
Man, 40 years old, weight 125 pounds	29
Two women, 39 and 22 years old, weights 155 and 100 pounds (58 meals × 0.8 meal of man), equivalent to	46
Two women, about 40 years each, weights 200 and 100 pounds (12 meals × 0.8 meal of man), equivalent to	10
Boy, 10 years old, weight 65 pounds (30 meals × 0.6 meal of man), equivalent to	18
Girl, 8 years old, weight 60 pounds (29 meals × 0.6 meal of man), equivalent to	17
Total number of meals taken equivalent to	120
Equivalent to 1 man for 40 days.	

In this study the weights of lard and maple sirup given are estimates. A considerable share of the lard was used in frying doughnuts, and much was thrown away unconsumed. It was impracticable to measure this. The record of the consumption of maple sirup as first entered was clearly erroneous, and the figure used is the average

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 28.

consumption of the family as observed at a later time. It is not probable, however, that anything more than a trifling error is introduced into the final results by these two assumptions.

Weights and cost of food and nutrients in dietary study No. 600.

Food consumed during the whole study (10 days).		Cost, nutrients, and fuel value of food per man per day.				
Kind and amount.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Beef and lamb: Rump steak, 438 grams, 23 cents (1); stew, 950 grams, 25 cents (16); dried, 174 grams, 12 cents (20); lamb, forequarter, 1,537 grams, 73 cents (24). Total, 3,099 grams	*Dollars.* 1.33	*Cents.* 3.3	*Grams.* 16	*Grams.* 15	*Grams.*	*Calories.* 198
Pork: Salt pork, 330 grams, 9 cents (140); lard, 500 grams, 14 cents (141); bacon, 90 grams, 3 cents (30). Total, 920 grams	.26	.7	......	21	......	187
Fish: Mackerel (dressed), 640 grams, 43 cents (142); cod, shredded, 60 grams, 5 cents (33). Total, 700 grams	.48	1.2	2	1	......	17
Eggs, shells removed, 1,561 grams, 48 cents (36)	.48	1.2	5	4	......	56
Butter, 2,760 grams, 125 cents (143)	1.25	3.1	1	59	......	541
Milk, 14,670 grams, 78 cents (40)	.78	2.0	13	17	18	275
Total animal food	4.58	11.5	37	117	18	1,274
VEGETABLE FOOD.						
Cereals: Malt oats, 885 grams, 13 cents (65); rice, 20 grams, 1 cent (82); flour, bread, 1,165 grams, 6 cents (47); flour, pastry, 1,900 grams, 10 cents (51); corn meal, 245 grams, 2 cents (53); bread, bakers', 7,445 grams, 110 cents (61); crackers, 105 grams, 2 cents (71); pie crust, 125 grams, 2 cents (78a); doughnuts, 65 grams, 2 cents (73); gingersnaps, 185 grams, 5 cents (75). Total, 12,140 grams	1.51	3.8	34	5	184	916
Sugars: Granulated, 2,325 grams, 32 cents (151); powdered, 220 grams, 4 cents (152); molasses, 275 grams, 3 cents (150); maple sirup, 1,500 grams, 31 cents (153); chocolate, 60 grams, 6 cents (177); cocoa, 60 grams, 7 cents (178). Total, 4,440 grams	.83	2.1	1	1	96	397
Vegetables: Asparagus, 1,115 grams, 20 cents (154); beans, 640 grams, 7 cents (85); horseradish tops, 275 grams, no cents (104); lettuce, 100 grams, 2 cents (100); mushrooms, field, 540 grams, no cents (94); onions, 350 grams, 3 cents (95); peas, canned, 1,045 grams, 20 cents (96); pickles, cucumber, 500 grams, 5 cents (159); potatoes, less skins, 12,005 grams, 30 cents (98); radishes, 335 grams, 10 cents (103); rhubarb, 2,225 grams, 25 cents (117); tomatoes, canned, 1,945 grams, 25 cents (160). Total, 21,075 grams	1.47	3.7	16	1	75	373
Fruits, etc.: Bananas, pulp only, 970 grams, 30 cents (163); lemons, 400 grams, 8 cents (164); raisins, 175 grams, 6 cents (116); strawberries, 813 grams, 18 cents (119); crabapple jelly, 272 grams (169); grape jelly, 285 grams (170); raspberry jam, 610 grams (174); marmalade, 595 grams (171); ginger pears, 500 grams (172); pineapple sauce, 528 grams (173); cost of last 6 items, 75 cents; pecan nut meats, 75 grams, 10 cents (176). Total, 4,923 grams	1.47	3.7	2	2	54	242
Total vegetable food	5.28	13.3	53	9	409	1,928
Total food	9.86	24.8	90	126	427	3,202
Waste: Meat waste, 580 grams (120); cereal waste, 1,300 grams (125); vegetable waste, 1,579 grams (131). Total waste, 3,459 grams			5	9	17	168
Food actually eaten			85	117	410	3,034

Considering the occupations of this family, they should probably be classed as doing light muscular work. The commonly accepted dietary standard for such persons calls for 100 grams of protein and about 3,000 calories of energy per day. When we compare the results of this study with this standard we see that the diet supplied notably less protein—85 grams, as against 100. This was probably due to the fact that the family under observation were from preference in the habit of eating small quantities of meat. In such a case it would very possibly be wise to increase the protein by a freer use of milk, either whole or skim. In the matter of energy the diet conforms well with the standard.

The kitchen waste is similar to that observed in dietary studies in the families of professional men previously reported in bulletins of this Office. It amounted to about 5 per cent of the edible portion of the total food; while this is not excessive, it will be seen to be higher than that in the other studies of the present series.

The cost of the food is practically the same as that in similar families previously studied. In nine studies made in the families of professional men in Connecticut, it averaged 25 cents as against 24.8 in the present case. It should be noted, however, that the cost of many articles of food has risen somewhat since the Connecticut studies were made, so that the comparison is more favorable to the Vermont dietary than at first appears. The materials used in the Vermont dietary which furnished the nutrients at the highest cost seem to have been fish and fruits, while, as usual, cereals and milk proved the least costly. The fish used contained less than one-half of 1 per cent of the total nutrients, but cost nearly one-twentieth of the whole amount expended. The fruits furnished only one-eleventh of the total nutrients, and these mainly in the form of carbohydrates, but represent more than one-seventh of the total cost. On the other hand, the cereals furnished over one-third of the nutrients at less than one-sixth of the total cost. The milk used furnished 7 per cent of the total food, and nearly 15 per cent of the protein, but represented only 8 per cent of the whole expenditure.

DIETARY STUDY No. 601.

This study was made on a Vermont farm, with a family consisting of a man, his wife, three sons, and two daughters. The farm was smaller than the one at which studies Nos. 602 and 603 were made, but three of the men were at active work. The fourth conducted the study and was engaged in farm work for one-half the time or less. The mother and older daughter were at moderately active work about the house. The study began August 7, 1901, and continued for ten days. The number of meals eaten was as follows.

error—one in the record of salt pork, of which the amount consumed was therefore estimated instead of measured, and the other in the fact that the household dog and chickens were fed from the weighed materials, an error it was impracticable to control, and no deduction was made. It is not likely, however, that these inaccuracies are sufficient to perceptibly affect the final results given in the table below.

The meals served in dietary study No. 602, the study made in the summer, were as follows:

	Meals.
Four men, 58, 40, 28, and 21 years old, weights 160, 125, 175 and 150 pounds	120
Four women, 55, 53, 50, and 25 years old, weights 220, 120, 100, and 120 pounds (102 meals × 0.8 meal of man), equivalent to	82
One woman, 40 years old, weight 155 pounds (6 meals × 0.8 meal of man), equivalent to	5
Boy, 11 years old, weight 65 pounds (30 meals × [illegible] meal of man), equivalent to	18
Girl, 8 years old, weight 60 pounds (30 meals × 0.[illegible] meal of man), equivalent to	18
Total number of meals taken equivalent to	243

Equivalent to 1 man for 81 days.

Weights and cost of food and nutrients in dietary study No. 602.

Food consumed during the whole study (10 days).		Cost, nutrients, and fuel value of food per man per day.				
Kind and amount.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Beef and lamb: Steak, round, 1,193 grams, 48 cents (2); steak, sirloin, 1,310 grams, 65 cents (3); dried, 87 grams, 5 cents (21); dried, cooked with milk, 855 grams, 10 cents (22); hearts, cooked, 225 grams, 50 cents (17); meat pie (with crust), 2,450 grams, 40 cents (19); lamb chops, cooked, 453 grams, 49 cents (26); lamb hind quarter, cooked, 700 grams, 71 cents (25).	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Total, 9,298 grams	3.38	4.2	29	12	3	235
Pork: Salt pork, 1,300 grams, 35 cents (140); ham, 1,027 grams, 36 cents (27); sausage, 803 grams, 20 cents (28); lard, 1,900 grams, 55 cents (141). Total, 5,030 grams	1.46	1.8	5	43	....	403
Poultry: Chickens, fricasseed, 1,840 grams, (31); chickens, steamed, 310 grams (32); total cost, $1.20. Total, 2,150 grams	1.20	1.5	5	1	....	29
Fish: Salt cod, 1,075 grams, 22 cents (33); salt salmon, 360 grams, 15 cents (34). Total, 1,435 grams	.37	.5	5	....	....	20
Eggs, without shells, 7,215 grams, $2.07 (38)	2.07	2.6	12	8	....	119
Butter, 4,510 grams, $1.80 (143)	1.80	2.2	1	47	....	422
Milk: Whole milk, 20,100 grams, 53 cents (41); skim milk, 18,670 grams, 8 cents (46); cream, 3,680 grams, 32 cents (44). Total, 42,450 grams	.93	1.1	18	21	26	363
Total animal food	11.21	13.9	75	132	29	1,591

Weights and cost of food and nutrients in dietary study No. 602—Continued.

Food consumed during the whole study (10 days).		Cost, nutrients, and fuel value of food per man per day.				
Kind and amount.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
VEGETABLE FOOD.						
Cereals: Cream of wheat, 390 grams, 12 cents (69); flour, 17,300 grams, 90 cents (48); corn meal, 1,020 grams, 5 cents (54); oatmeal, 395 grams, 4 cents (66); graham flour, 2,395 grams, 18 cents (57); rice, 210 grams, 5 cents (83); bread, 2,065 grams, 30 cents (62); doughnuts, 218 grams, 7 cents (145); gingerbread, 615 grams, 15 cents (146). Total, 24,608 grams	*Dollars.* 1.86	*Cents.* 2.3	*Grams.* 33	*Grams.* 4	*Grams.* 220	*Calories.* 1,047
Sugars, etc.: Granulated sugar, 6,858 grams, 95 cents (151); molasses, 1,788 grams, 20 cents (150); honey, comb, 2,260 grams, 60 cents (149); cocoa, 160 grams, 18 cents (178). Total, 12,066 grams	1.93	2.4	1	1	123	505
Vegetables: Beans, dried, 1,525 grams, 15 cents (86); beans, green, 1,512 grams [illegible] cents (155); beets, 2,314 grams, 15 cents [illegible]rn, kernels, cooked, 9,670 grams, $1. [illegible]); cucumbers, sliced, 1,825 grams, 40 ce[illegible] (158); lettuce, 730 grams, 10 cents (160); peas, green, 1,540 grams, 30 cents (97); potatoes, peeled, cooked, 29,555 grams, 90 cents (99). Total, 48,671 grams	4.00	5.0	23	3	101	523
Fruits, etc.: Apples, for sauce, pies, and baking, 6,285 grams, 14 cents (109); apple sauce, 5,305 grams, 25 cents (111); bananas, pulp only, 1,115 grams, 35 cents (163); blackberries, 1,435 grams, 30 cents (113); lemons, 220 grams 10 cents (164); raisins, 128 grams, 4 cents (116). Total, 14,488 grams	1.18	1.4	1		25	104
Total vegetable food	8.97	11.1	58	8	469	2,179
Total food	20.18	25.0	133	140	498	3,770
Waste: Meat waste, 892 grams (122a); cereal waste, 1,736 grams (127a); vegetable waste, 2,295 grams (133a). Total, 4,923 grams			4	5	12	108
Food actually eaten			129	135	486	3,662

The ages and weights of the members of the family, and the number of meals taken by each in dietary study No. 603, were as follows:

	Meals.
Man, age 58 years, weight 160 pounds Man, age 29 years, weight 175 pounds Man, age 27 years, weight 150 pounds	98
Woman, age 55 years, weight 200 pounds (33 meals × 0.8 meal of man), equivalent to	26
Three visitors and farm help	8
Woman, visitor (1 meal × 0.8 meal of man), equivalent to	1
Total number of meals equivalent to	133

Equivalent to 1 man for 44 days.

DIETARY STUDIES OF FAMILIES LIVING IN THE MOUNTAIN REGION OF EASTERN TENNESSEE.

By CHARLES E. WAIT, Ph. D., F. C. S.,
Professor of Chemistry in the University of Tennessee.

INTRODUCTION.

There are few types of people in the United States more interesting from the historical and sociological standpoints than the mountaineers of the remote districts of our southeastern mountain ranges. They are also of interest to the student of the physiology of nutrition because they are supposed to live on diets very cheap, simple, and poor in nutritive ingredients, or at least not well balanced, and yet to be fairly well developed physically. It was therefore felt that dietary studies made among them would be of unusual value; and considering their peculiar history and their somewhat unusual position at the present day, that any facts which could at the same time be gathered regarding their habits and surroundings would add greatly to the interest of the work. Accordingly the studies here reported were instituted as a part of the nutrition investigations carried on in different parts of the United States under the auspices of the Office of Experiment Stations.

The data recorded in these studies, seventy in number, were collected at different times during the years 1901 to 1905, and in different localities in eastern Tennessee, and have been prepared for publication as occasion offered. The general history and character of the region and the people are briefly described in the following paragraphs:

HISTORICAL SKETCH OF TENNESSEE MOUNTAIN SETTLEMENTS.

When, shortly before the Revolutionary war, some of the more adventurous dwellers in the seaboard colonies began to make their way across the Appalachian Mountains, those from North Carolina, Virginia, and some even from Pennsylvania found the easiest course down the western slopes to be along the streams which later join to make the Tennessee River. The first permanent settlements in this new region were along their banks; and when, a few years later,

those in most common use must be obtained from Maryville. There is considerable timber on the mountains near by, and some of the men work in sawmills and gristmills in the neighborhood; otherwise the people make their living mainly from their farms, which are mostly small and difficult of cultivation. It is believed that Crooked Creek is typical of the isolated mountain settlements of eastern Tennessee.

The houses there are poorer than near the towns. The majority are built of logs, and even the frame houses are very roughly constructed. A few contain four rooms or more; a few others have only one, but the great majority consist of two rooms, one of which is used as a sleeping or living room for the whole family, and the other as kitchen and dining room. Sometimes the windows are glazed, but not infrequently they consist simply of a hole in the wall, with a wooden shutter for use in case of cold or rain. Many of the rooms and one or two of the houses have no windows at all. The chimneys are usually crude affairs of brick, stones, or even logs and clay, built on the outside of the house. In fact, many of these houses are practically the same as the log cabins of the backwoodsmen who settled the region a hundred or more years ago. The rent, of course, depends somewhat upon the amount and quality of the land which goes with the house. The size of the lots varies from small garden plats to good-sized farms. The rent of the farm land, however, is frequently paid by a share of the crop. In several cases married children share the farm with the parents, probably paying rent in labor. When money is paid for the rent of a house and home lot the sum varies from 50 cents to $2.50 a month, with $1 or $1.50 as the most common price. Some of the families raised vegetables, and even more grew corn for home use. This corn they carried to the local mill and left it to be ground. Needless to say, the method of grinding was primitive and relatively expensive.

The furnishings of these mountain homes correspond to the character of the houses. Beds, rough chairs, and a table are frequently the only furniture. Cooking stoves are even less common than in the houses near town. Things which are mainly ornamental and not strictly necessary, such as wall paper, window curtains, carpets, etc., are almost never seen, and in general there seems to be less incentive to keep the places looking well than in the case of the houses near town.

The families in the remote districts dress even more simply and cheaply than those in and near town.

Very few of the families among whom these studies were made were at first disposed to let their bills of fare or their cost of living be known, especially as they did not easily understand the purpose of the

studies. They would not give their consent to the work until they had been approached by persons whom they knew and trusted. In all cases compensation for their cooperation was given.

METHOD OF CONDUCTING THE INVESTIGATIONS.

The general plan of these studies was that followed in the family dietaries already reported in various bulletins of this Office.[a] It consists in ascertaining the weight, composition, and cost of all the food used by the family during the assigned period, and the number of meals served. The waste is also collected and analyzed. The amounts of nutrients supplied by each class of food materials and by the total food are then calculated from these data. The usual assumptions are made regarding the relative amounts of food consumed by persons of different age and sex [b] in determining the amount consumed per man per day.

The studies were continued through fourteen days each, and it is believed that they represent as accurately as possible the dietary habits of these families at the season when they were made. The first four (Nos. 604–607) were made during the winter of 1900–1901; the next three (Nos. 608–610) in the spring of 1902; the next nineteen (Nos. 611–629) in the winter of 1902–3; Nos. 630–648 in the autumn of 1903; and the last series (Nos. 649–667) in the summer of 1904. The Maryville studies represent the diets of people in the same locality at different times of the year and probably show whatever peculiarities the various seasons cause in the diet. The last series contains all the studies made in remote districts, and shows only late summer dietaries. But as they contain very few of the fresh fruits and vegetables, poultry and eggs, which ordinarily distinguish summer from winter dietaries, we may infer that there was little difference in the food from month to month. It is possible that small game increased the amount of meat used at certain seasons.

Besides the usual data regarding the number, age, weight, and occupations of persons in each family, the observers in these studies gave full reports regarding their financial condition, the character of the house and furniture, the extent and quality of the land and crops, the number and value of the animals, and tools and farming implements found about the place, and were requested to answer questions on several other points. Photographs were taken of all the houses, and some of them are reproduced in the accompanying plates. It may be remarked in passing that the persons who appear in these pictures are not in every case all or only the members of the family

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 38, 46, 71, etc.

[b] U. S. Dept. Agr., Farmers' Bul. 142.

Prices of the different food materials used in the dietary studies in Tennessee—Cont'd.

Kind of food.	Range in price per pound.	Usual price per pound.
VEGETABLE FOOD—continued.		
Fruits:	*Cents.*	*Cents.*
Apples (60 cents–$1.50 per bushel)		2
Apples, dried	4–10	5
Apples, canned	10	10
Apple jelly	10	10
Apple butter	10	10
Blackberries, canned	6–8	7
Blackberries, dried (20 cents per gallon)		5
Blackberry jelly	10	10
Citron	10	10
Gooseberries, dried (20 cents per gallon)		5
Gooseberries, canned	6–10	7
Grapes, canned (20 cents per gallon)		
Huckleberries, canned	5–10	7
Muskmelon	2	2
Peaches, dried	8–15	12
Peaches, canned	6–8	7
Preserves, watermelon	10	10
Quince jelly		

Chemical composition of food materials analyzed in dietary studies Nos. 604–681.

Reference No.	Kind of food.	Protein.	Fat.	Carbohydrates.
	ANIMAL FOOD.			
	Beef:	*Per cent.*	*Per cent.*	*Per cent.*
1	Chuck	15.2	6.6	
2	Shank as purchased	6.7	1.9	
3	Shank, edible portion	21.0	5.8	
4	Shoulder, clod	18.5	4.7	
5	Side	15.3	10.5	
6	Steak, round	19.2	7.0	
7	Liver	20.2	3.1	2.5
	Pork:			
8	Chuck ribs	14.1	25.5	
9	Head	4.1	13.8	
10	Shoulder	12.0	29.8	
11	Liver	21.3	4.5	1.4
12	Lard		100.0	
13	Ham, smoked	14.5	33.2	
14	Salt, fat	7.9	73.2	
15	Shoulder, salt	12.6	33.0	
16	Sausage	11.8	47.1	
	Fish:			
17	Perch	6.6	.2	
18	Sardines, canned	23.7	12.1	
19	Game: Rabbit	13.9	8.7	
20	Eggs	13.1	9.3	
	Dairy products:			
21	Butter	1.9	82.7	
22	Milk	4.1	1.1	5.6
23	Do	2.3	3.2	4.6
24	Do	3.2	3.5	5.2
25	Buttermilk	3.0	.6	3.4
26	Do	2.8	.6	3.9
27	Do	3.1	1.7	3.2
28	Do	3.4	.6	3.3
29	Do	2.8	.6	3.1
30	Do	2.9	.6	4.8
31	Milk, skimmed	3.4	.3	5.1
	VEGETABLE FOOD.			
	Cereals:			
32	Corn meal, bolted	7.8	3.4	72.3
33	Corn meal, unbolted	7.5	4.2	65.9
34	Hominy	8.3	.6	79.0
35	Oats, rolled	16.7	7.3	66.2
36	Rice	8.0	.3	79.0
37	Wheat flour	10.1	1.0	77.8
38	Bread, corn	8.1	7.9	45.0
39	Bread, white	9.8	.7	57.1
40	Biscuit, soda	9.3	13.7	52.6
41	Pie, blackberry	4.6	9.5	39.6

Chemical composition of food materials analyzed in dietary studies Nos. 604–681—Cont'd.

Reference No.	Kind of food.	Protein.	Fat.	Carbohydrates.
	VEGETABLE FOOD—continued.			
	Sugars, starches, etc.:	*Per cent.*	*Per cent.*	*Per cent.*
42	Honey	0.4		81.2
43	Molasses	2.4		69.3
44	Sugar, brown			95.0
45	Sugar, granulated			100.0
	Vegetables:			
46	Beans, butter	9.4	0.6	29.1
47	Beans, string	2.3	.3	7.4
48	Beans, dried	20.7	1.6	62.5
49	Beans, pickled	1.1	.1	3.8
50	Beets, pickled	2.3	.1	7.4
51	Cabbage	1.6	.3	5.6
52	Corn	3.1	1.1	19.7
53	Corn, canned	2.8	1.2	19.0
54	Cowpeas, Clay, dried	22.4	1.6	61.9
55	Do	21.9	1.8	61.8
56	Cowpeas, Whippoorwill, dried	21.5	1.5	63.5
57	Onions	1.4	.3	8.9
58	Peas, dried	24.6	1.0	62.0
59	Peas, canned	3.6	.2	9.8
60	Parsnips	1.3	.4	10.8
61	Pickles, cucumber	.5	.3	2.7
62	Potatoes	2.2	.1	18.4
63	Pumpkins	.5	.1	2.6
64	Pumpkin, dried	7.1	1.8	59.9
65	Pumpkin butter	.8	.2	6.7
66	Rhubarb	.4	.4	2.2
67	Sauerkraut	1.7	.5	3.8
68	Sweet potatoes	1.8	.7	27.4
69	Tomatoes	.9	.4	3.9
70	Tomatoes, canned	1.2	.2	4.0
71	Turnips as purchased	.9	.1	5.7
72	Turnips, edible portion	1.3	.2	8.1
	Fruits, etc.:			
73	Apples	.3	.3	10.8
74	Apples, dried	1.6	2.2	66.1
75	Apples, canned	.3	2.4	54.4
76	Apple jelly	1.1		77.2
77	Apple butter	.2	.8	37.2
78	Blackberries, canned	.8	2.1	56.4
79	Blackberries, dried	2.4	1.7	74.2
80	Blackberry jelly	1.1		77.2
81	Citron	.5	1.5	78.1
82	Gooseberries, dried	2.4	1.7	74.2
83	Gooseberries, canned	.6	.6	12.8
84	Grapes, canned	.6	.6	12.8
85	Huckleberries, canned	.6	.6	12.8
86	Muskmelons	.3		4.6
87	Peaches, dried	4.7	1.0	62.5
88	Peaches, canned	.7	.1	10.8
89	Preserves, watermelon	.5	1.5	78.1
90	Quince jelly	1.1		77.2

In the table reporting the experimental data for each dietary study figures in parentheses will be found after the different kinds of foods. These indicate the data used in computing the nutritive material supplied by the quantity of each food, Nos. 1 to 90, inclusive, being the reference numbers for the foods included in the table above, while the remaining numbers refer to average figures for the composition of foods summarized in a manuscript table on file in the Office of Experiment Stations.

The study began February 11, 1901. The age of each member of the family, and the number of meals taken by each, was as follows:

	Meals.
Man, age 61 years	42
Man, visitor	1
Woman, age 33 years (42 meals×0.8 meal of man), equivalent to	34
Women (2), visitors	2
Child, age 10 years (42 meals×0.6 meal of man), equivalent to	25
Child, age 8 years (42 meals×0.5 meal of man), equivalent to	21
Child, age 6 years (42 meals×0.5 meal of man), equivalent to	21
Child, age 3 years (42 meals×0.4 meal of man), equivalent to	17
Total number of meals equivalent to	163

Equivalent to 1 man for 54 days.

Weights and cost of food and nutrients in dietary study No. 605.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Side, 2 pounds, 20 cents (5)	0.20	0.4	3	2	....	30
Pork: Chuck ribs, 4 pounds, 20 cents (8); lard, 2.25 pounds, 23 cents (12); sausage, 1 pound, 10 cents (16)	.53	1.0	6	31	....	300
Butter, 1 pound, 20 cents (21)	.20	.4	....	7	....	62
Milk, 29 pounds, 73 cents (22)	.73	1.3	10	3	14	123
Buttermilk, 39.06 pounds, 26 cents (28)	.26	.5	11	2	11	106
Total animal food	1.92	3.6	30	45	25	621
VEGETABLE FOOD.						
Cereals: Corn meal, 35.25 pounds, 42 cents (33); flour, wheat, 25.5 pounds, 61 cents (37)	1.03	1.9	44	14	362	1,748
Sugars, starches, etc.: Sugar, brown, 3.25 pounds, 16 cents (44)	.16	.3	....	....	26	104
Vegetables: Beans, dried, 1 pound, 5 cents (48); cowpeas, Clay, dried, 2 pounds, 6 cents (54); onions, 2 pounds, 4 cents (57); sweet potatoes, 23 per cent refuse, 6.5 pounds, 7 cents (68)	.22	.4	6	1	28	145
Fruits, etc.: Peaches, dried, 1 pound, 12 cents (87)	.12	.2	....	....	5	20
Total vegetable food	1.53	2.8	50	15	421	2,017
Food actually eaten	3.45	6.4	80	60	446	2,638

The food consumed in this study furnished 80 grams protein, 60 grams fat, and 446 grams carbohydrates, with an energy value of 2,638 calories. From these figures it will be seen that the amounts of protein and energy are very well proportioned, though both are low. The cost, 6.4 cents per man per day, is extremely low for a diet furnishing the nutrients and energy which this does. It is noticeable also that no waste is reported, which shows extreme economy in the household management.

Corn meal and flour are the two foods used most extensively in this study, showing that this family relied on cereal foods for more than

one-half of the protein and 66 per cent of the energy supplied. As these are both very cheap foods, this is another instance of economy. It is, however, probable that these people acted from habit rather than knowledge. The diet for families in such conditions was fairly varied. In spite of its good features, however, it is doubtful whether this diet was adequate to the needs of the family.

DIETARY STUDY No. 606.

This study was made with a family consisting of a widow and two daughters. The income is not stated. They had no occupation other than the usual household work. The house in which they lived appears to have been rather better than the average.

The study began February 11, 1901. The age of each member of the family, and the number of meals taken by each, was as follows:

	Meals.
Woman, age 55 years (41 meals × 0.8 meal of man), equivalent to....	33
Woman, age 21 years (41 meals × 0.8 meal of man), equivalent to....	33
Woman, age 17 years (40 meals × 0.8 meal of man), equivalent to....	32
Total number of meals equivalent to..........................	98
Equivalent to 1 man for 33 days.	

Weights and cost of food and nutrients in dietary study No. 606.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Chuck ribs, 6 pounds, 30 cents (8); salt fat, 5.25 pounds, 53 cents (14); sausage, 0.25 pound, 2 cents (16)..........	*Dollars.* 0.85	*Cents.* 2.6	*Grams.* 18	*Grams.* 75	*Grams.*	*Calories.* 740
Eggs, 1.5 pounds, 15 cents (20)..........	.15	.4	2	2	......	26
Butter, 2.5 pounds, 50 cents, (21)..........	.50	1.5	1	28	......	253
Milk, 2.5 pounds, 6 cents (23)..........	.06	.2	1	1	2	21
Buttermilk, 32.5 pounds, 20 cents (27)..........	.20	.6	14	8	14	183
Total animal food..........	1.76	5.3	36	114	16	1,223
VEGETABLE FOOD.						
Cereals: Corn meal, 16.31 pounds, 29 cents (33); flour, wheat, 17.88 pounds, 43 cents (37); bread, white, 1.5 pounds, 6 cents (39)..........	.69	2.1	44	12	351	1,687
Sugars, starches, etc.: Sugar, brown, 1 pound, 5 cents (44)..........	.05	.1	......	......	13	52
Vegetables: Cabbage, 6.5 pounds, 13 cents (51); sauerkraut, 4 pounds, 8 cents (67); sweet potatoes, 6 per cent refuse, 13 pounds, 13 cents (68); turnips, 21 per cent refuse, 7 pounds, 4 cents (72)..........	.38	1.2	6	2	59	278
Fruits, etc.: Apples, 1 pound, 2 cents (73); apples, dried, 1 pound, 5 cents (74); apple jelly, 1.5 pounds, 15 cents (76); blackberries, canned, 9.5 pounds, 68 cents (78); peaches, canned, 6 pounds, 42 cents (88)..........	1.32	4	2	3	109	470
Total vegetable food..........	2.44	7.4	52	17	532	2,487
Total food..........	4.20	12.7	88	131	548	3,710
Food wasted..........			2	1	15	77
Food actually eaten..........	4.20	12.7	86	130	533	3,633

Though nothing is known concerning the muscular activity of the persons studied, the data of the above table would indicate that the amount of food consumed was probably nearly sufficient for their needs. The energy is much higher than would be expected. The cost is nearly 4 cents higher than the average of these studies, as might be expected from the variety of food materials used. The waste is, as in almost all of these studies, very small in nutritive value. It would appear from the general conditions of this family, as reported by the observer, that they were rather above the average of the families studied as regards income and standards of life.

DIETARY STUDY No. 607.

The family here studied was very poor. The man was physically unable to do more than a little work, and the family was largely supported by the mother, who took in washing. They paid $1 per month for the rent of the two rooms in which they lived.

This study began February 11, 1901, and was continued for the usual period. The ages of the different subjects, and the number of meals taken by each, were as follows:

	Meals.
Man, age 26 years	42
Woman, age 23 years (34 meals × 0.8 meal of man), equivalent to	27
Boy, age 6 years (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 5 years (42 meals × 0.4 meal of man), equivalent to	17
Girl, age 2 years (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	124

Equivalent to 1 man for 41 days.

Weights and cost of food and nutrients in dietary study No. 607.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Head, 12.75 pounds, 32 cents (9); salt fat, 6.25 pounds, 63 cents (14)	0.95	2.3	11	70		667
Buttermilk, 104.75 pounds, 65 cents (26)	.65	1.6	33	7	45	374
Total animal food	1.60	3.9	44	77	45	1,041
VEGETABLE FOOD.						
Cereals: Corn meal, 35.81 pounds, 43 cents (33); flour, wheat, 23 pounds, 55 cents (37)	.98	2.4	55	19	459	2,225
Vegetables: Turnips, 15 per cent refuse, 8.5 pounds, 4 cents (72)	.04	.1	1		6	28
Fruits, etc.: Apples, 1.5 pounds, 3 cents (73)	.03	.1			2	8
Total vegetable food	1.05	2.6	56	19	467	2,261
Total food	2.65	6.5	100	96	512	3,302
Food wasted			1	1	8	45
Food actually eaten	2.65	6.5	99	95	504	3,257

The table on page 34 shows a decided lack of variety in the diet. Only seven articles of food were consumed during the two weeks of the study. Yet this family obtained 99 grams protein and 3,257 calories energy, which is more than the equivalent in protein and considerably in excess in energy of the standard for man at sedentary occupation or woman with moderately active muscular work. As far as may be judged from the data reported, this standard corresponded fairly well with the activity of the household. It would, therefore, seem that they were sufficiently nourished. The cost of the diet, 6.5 cents per man per day, is very small, doubtless owing to the fact that the family lived very largely on two articles of food, both furnishing large amounts of protein and energy in proportion to their cost, namely, buttermilk and corn meal. About 70 per cent of the fat used was derived from the use of fat salt pork.

DIETARY STUDY No. 608.

Dietary study No. 608 is the first of those made in or near Maryville, and was made with a family of three, a woman and her two boys. They occupied a three-room house. The mother took in washing to support the family, but the amount of her income is unknown.

The study began March 31, 1902. The ages and weights of the several members of the family, and the number of meals taken by each, were as follows:

	Meals.
Woman, age 22 years, weight 105 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 5 years, weight 48 pounds (42 meals × 0.4 meal of man), equivalent to	17
Boy, age 3 years, weight 32 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals taken equivalent to	68

Equivalent to 1 man for 23 days.

Weights and cost of food and nutrients in dietary study No. 608.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 1 pound, 10 cents (12); ham, smoked, 1 pound, 15 cents (13); salt fat, 1.5 pounds, 15 cents (14)	*Dollars.* 0.40	*Cents.* 1.7	*Grams.* 5	*Grams.* 48	*Grams.*	*Calories.* 447
Eggs, 0.25 pound, 3 cents (20)	.03	.1	1			4
Butter, 2.25 pounds, 45 cents (21)	.45	2.0	1	37		333
Buttermilk, 14.5 pounds, 9 cents (25)	.09	.4	8	2	10	90
Total animal food	.97	4.2	15	87	10	874

Weights and cost of food and nutrients in dietary study No. 608—Continued.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
VEGETABLE FOOD.						
Cereals: Corn meal, 5 per cent refuse, 4.75 pounds, 6 cents (33); flour, wheat, 10.94 pounds, 26 cents (37)	*Dollars.* 0.32	*Cents.* 1.4	*Grams.* 29	*Grams.* 6	*Grams.* 226	*Calories.* 1,073
Sugars, starches, etc.: Sugar, granulated, 6.94 pounds, 42 cents (45)	.42	1.8			137	548
Vegetables: Beans, dried, 1 pound, 5 cents (48); cabbage, 4.5 pounds, 9 cents (51); peas, dried, 2 pounds, 10 cents (58); potatoes, 18 per cent refuse, 4.88 pounds, 6 cents (62)	.30	1.3	17	1	56	301
Total vegetable food	1.04	4.5	46	7	419	1,922
Total food	2.01	8.7	61	94	429	2,796
Food wasted			1	1	9	49
Food actually eaten	2.01	8.7	60	93	420	2,747

It seems very certain from the results given in the above table that the nutrients supplied, 60 grams protein, 93 grams fat, 420 grams carbohydrates, and 2,747 calories of energy, were insufficient for the needs of the family. The protein in particular is low. The cost of this diet, 8.7 cents, is higher than that in the preceding study (6.5), though the diet furnished one-third less protein and but 84 per cent of the energy. This is accounted for by the fact that in this study butter was used, while in the other it was not. This is not meant to imply that butter is an unimportant article in the diet, but that where it is absolutely necessary to obtain the most nutriment at the least possible cost, as would seem to have been the case here, other foods yielding more nutriment for the same amount of expenditure might be purchased.

DIETARY STUDY No. 609.

The following study was made with the family of a "section hand" employed on the railroad. His employment on the railroad was irregular, and he worked in a brickyard a part of the time. His average wage was $1 per day. The family occupied a two-room house (Pl. I, fig. 1), for which they paid $2 rent. They had a small garden and raised some vegetables. Among this class of people, where, as far as may be judged from this series of studies, regular employment seems to have been rare, this family might be said to be reasonably well situated.

The study began March 31, 1902. The ages and weights of the members of the family, and the number of meals taken by each member, were as follows.

FIG. 1.—HOME OF SECTION HAND. DIETARY STUDY NO. 609.

FIG. 2.—HOME OF STATIONARY ENGINEER. DIETARY STUDY NO. 610.

	Meals.
Man, age 23 years, weight 154 pounds	39
Woman, age 19 years, weight 129 pounds (40 meals × 0.8 meal of man), equivalent to	32
Boy, age 2 years, weight 25 pounds (40 meals × 0.4 meal of man), equivalent to	16
Visitor, boy, age 16 years	2
Total number of meals equivalent to	89

Equivalent to 1 man for 30 days.

Weights and cost of food and nutrients in dietary study No. 609.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 2.75 pounds, 28 cents (12); ham, smoked, 0.63 pound, 10 cents (13); salt fat, 6.63 pounds, 64 cents (14)	*Dollars.* 1.02	*Cents.* 3.4	*Grams.* 9	*Grams.* 118	*Grams.*	*Calories.* 1,086
Buttermilk, 8.69 pounds, 5 cents (25)	.05	.2	4	1	5	45
Total animal food	1.07	3.6	13	119	5	1,131
VEGETABLE FOOD.						
Cereals: Corn meal, 3.06 pounds, 4 cents (33); flour, wheat, 21.19 pounds, 51 cents (37); biscuit, 2.38 pounds, 10 cents (40)	.65	2.2	39	10	298	1,437
Sugars, starches, etc.: Molasses, 2.63 pounds, 8 cents (43); sugar, brown, 2 pounds, 10 cents (44)	.18	.6	1	....	56	228
Vegetables: Beans, dried, 5.13 pounds, 25 cents (48); cabbage, 1.88 pounds, 4 cents (51); peas, dried, 2 pounds, 10 cents (58)	.39	1.3	24	1	69	381
Fruits, etc.: Peaches, dried, 1 pound, 12 cents (87); quince jelly, 1 pound, 10 cents (90)	.22	.7	1	....	21	88
Total vegetable food	1.44	4.8	65	11	444	2,134
Total food	2.51	8.4	78	130	449	3,265
Food wasted			2	1	12	65
Food actually eaten	2.51	8.4	76	129	437	3,200

From the above table it will be seen that the diet studied furnished 76 grams protein, 129 grams fat, and 437 grams carbohydrates, with a fuel value of 3,200 calories. The energy supplied was probably not far from adequate to the needs of the persons studied, but the protein is small in amount. The amount of protein from animal food was very small, being only about 17 per cent of the total. The cost was about medium.

DIETARY STUDY No. 610.

The subjects of this study were the members of a stationary engineer's family. The father was employed in a planing mill, but only irregularly. Their income was very small, though not precisely stated. The average was probably not far from $2.50 per week. The family occupied a three-room cabin (Pl. I, fig. 2).

The study began April 16, 1902, and was continued for the usual time. The ages and weights of the different members of the family, and the number of meals eaten, were as follows:

	Meals.
Man, age 31 years, weight 133 pounds	41
Woman, age 33 years, weight 135 pounds (42 meals×0.8 meal of man), equivalent to	34
Girl, age 6 years, weight 35 pounds (41 meals×0.5 meal of man), equivalent to	21
Boy, age 4 years, weight 30 pounds (41 meals×0.4 meal of man), equivalent to	16
Girl, age 6 months, weight 20 pounds (41 meals×0.3 meal of man), equivalent to	12
Girl, age 12 years (1 meal×0.6 meal of man) Girl, age 15 years (1 meal×0.8 meal of man) } equivalent to	1
Total number of meals equivalent to	125

Equivalent to 1 man for 42 days.

Weights and cost of food and nutrients in dietary study No. 610.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 2 pounds, 20 cents (12); salt fat, 2.5 pounds, 25 cents (14)	0.45	1.1	2	41		373
Fish: Sardines, canned, 0.25 pound, 10 cents (18)	.10	.2				
Eggs, 1.19 pounds, 12 cents (20)	.12	.3	2	1		17
Butter, 3.75 pounds, 75 cents (21)	.75	1.8	1	34		306
Buttermilk, 24 pounds, 15 cents (25)	.15	.3	8	2	9	86
Total animal food	1.57	3.7	13	78	9	782
VEGETABLE FOOD.						
Cereals: Flour, wheat, 41.44 pounds, $1 (37)	1.00	2.4	45	5	348	1,616
Sugars, starches, etc.: Molasses, 6.5 pounds, 20 cents (43); sugar, granulated, 3.25 pounds 20 cents (45)	.40	1.0	2		84	344
Vegetables: Beans, dried, 9 pounds, 45 cents (48); cabbage, 1.75 pounds, 4 cents (51); corn, canned, 6.25 pounds, 63 cents (53); cucumber pickles, 0.5 pound, 5 cents (61); peas, canned, 1.25 pounds, 8 cents (59); potatoes, 18 per cent refuse, 5.19 pounds, 7 cents (62)	1.32	3.1	24	2	85	454
Fruits, etc.: Peaches, canned, 2 pounds, 14 cents (88)	.14	.3			2	8
Total vegetable food	2.86	6.8	71	7	519	2,422
Total food	4.43	10.5	84	85	528	3,204
Food wasted			1	1	10	53
Food actually eaten	4.43	10.5	83	84	518	3,151

The cost per man per day in the table above is somewhat greater than the average of those here reported. The variety of the diet is considerable, which in some measure probably accounts for the increased cost, since the nutrients and energy are not correspondingly high. It would seem that from so varied a diet and such a (relatively) high cost, greater nutritive value might have been obtained. It is quite possible, however, that the nutrients supplied were quite or nearly sufficient for the needs of the family, especially if the man was out of

work during the period. All other things being equal, such a varied diet is certainly more desirable than that observed in dietary study No. 608, for example.

DIETARY STUDY No. 611.

This dietary study was made with a widow and her son. Both worked, the woman taking in washing and the son doing job work. Their income was, therefore, uncertain, and varied considerably from week to week. They had a small garden, where they raised some vegetables. They occupied a two-room house, which they rented for $2 per month.

The study began December 7, 1902. The number of meals taken, with the age and weight of the two subjects, is given below:

	Meals.
Woman, age 39 years, weight 120 pounds (42 meals×0.8 meal of man), equivalent to	34
Boy, age 13 years, weight 105 pounds (42 meals×0.8 meal of man), equivalent to	33
Total number of meals equivalent to	67

Equivalent to 1 man for 22 days.

Weights and cost of food and nutrients in dietary study No. 611.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat	Carbohydrates.	Fuel value.
ANIMAL FOOD.	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Beef: Shoulder clod, 1.5 pounds, 15 cents (4)	0.15	0.7	5	1	..	29
Pork: Lard, 1 pound, 10 cents (12); salt fat, 7.5 pounds, 75 cents (14); sausage, 1.5 pounds, 25 cents (16)	1.10	5.0	16	148	......	1,381
Butter, 1.5 pounds, 30 cents (21)	.30	1.3	1	26	......	235
Total animal food	1.55	7.0	22	175	......	1,645
VEGETABLE FOOD.						
Cereals: Corn meal, 23 pounds, 28 cents (33); flour, wheat, 11 pounds, 26 cents (37); bread, white, 0.5 pound, 2 cents (39)	.56	2.6	60	22	495	2,416
Sugar, starches, etc.: Molasses, 3 pounds, 9 cents (43)	.09	.4	1	......	43	176
Vegetables; Cowpeas, dried, 1 pound, 3 cents (56); sweet potatoes, 6 per cent refuse, 4 pounds, 4 cents (68)	.07	.3	6	1	34	169
Total vegetable food	.72	3.3	67	23	572	2,761
Total food	2.27	10.3	89	198	572	4,406
Food wasted	......	......	3	2	16	94
Food actually eaten	2.27	10.3	86	196	556	4,312

The table above shows a diet high in energy, but low in protein. This seems somewhat typical of the diet of this class of people in this locality, a high energy value being obtained from the large amounts of fat pork and corn meal used.

The cost, 10.3 cents, is higher than the average for these studies, but the reason for this can not be definitely stated, since the diet

shows little variety, and there is no item in particular which seems to have caused the difference. In proportion to the protein and energy furnished, the cost is also above the average for the studies here reported.

DIETARY STUDY No. 612.

Dietary study No. 612 was made with a family of five persons. The father and son were both wage-earners, their combined wage amounting to about $9 per week. The older woman also earned some money by knitting.

The study began December 7, 1902. The ages and weights of the several members of the family, and the number of meals taken by each, are given below:

	Meals.
Man, age 54 years, weight 150 pounds	42
Man, age 54 years, weight 140 pounds	42
Woman, age 54 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 17 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	33
Girl, age 5 months, weight 13 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	164

Equivalent to 1 man for 55 days.

Weights and cost of food and nutrients in dietary study No. 612.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shank, 23 pounds, $1.15 (3)	1.15	2.1	40	11	....	258
Pork: Chuck ribs, 26 pounds, $1.30 (8); lard, 1.5 pounds, 15 cents (12)	1.45	2.6	30	67	....	716
Butter, 2.5 pounds, 50 cents (21)	.50	.9	....	17	....	151
Total animal food	3.10	5.6	70	95	....	1,125
VEGETABLE FOOD.						
Cereals: Corn meal, 8.5 pounds, 10 cents (33); flour, wheat, 38 pounds, 91 cents (37)	1.01	1.8	37	6	290	1,361
Sugar, starches, etc.: Molasses, 12 pounds, 30 cents (43); sugar, granulated, 4 pounds, 24 cents (45)	.54	1.0	2	....	102	416
Vegetables: Sweet potatoes, 15 per cent refuse, 50 pounds, 50 cents (68); turnips, 7 pounds, 4 cents (71)	.54	1.0	7	3	99	451
Total vegetable food	2.09	3.8	46	9	491	2,228
Total food	5.19	9.4	116	104	491	3,353
Food wasted	....	....	1	2	7	50
Food actually eaten	5.19	9.4	115	102	484	3,303

The above table indicates that this family received a diet costing 9.4 cents per man per day, which probably yielded a sufficient amount of protein and energy to correspond with their muscular activity, the protein and energy being proportioned almost exactly to the dietary

standard. Only ten articles of food were used during the two weeks, showing plainly the extreme simplicity of the diet. This study more nearly approaches the ordinary dietary as regards the proportions of protein and energy derived from animal and vegetable food than any other here reported.

DIETARY STUDY No. 613.

This study was made with the family of a sawmill operative. From data reported it is evident that they were poor, but economical and industrious. They occupied a two-room house, which they rented for $2 per month.

The study began December 22, 1902. The data concerning the members of the family, their ages, weights, and the number of meals taken by each, are given below:

	Meals.
Man, age 32 years, weight 160 pounds	42
Woman, age 27 years, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 64 years, weight 150 pounds (42 meals × 0.8 meal of man), equivalent to	33
Girl, age 7 years, weight 40 pounds (42 meals × 0.5 meal of man), equivalent to	21
Total number of meals equivalent to	130

Equivalent to 1 man for 43 days.

Weights and cost of food and nutrients in dietary study No. 613.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 3.75 pounds, 38 cents (12); salt, fat, 3 pounds, 30 cents (14)	0.68	1.6	3	63	....	573
Butter, 3 pounds, 60 cents (21)	.60	1.4	1	26	....	235
Buttermilk, 19 pounds, 12 cents (25)	.12	.3	6	1	7	61
Milk, skimmed, 18 pounds, 14 cents (31)	.14	.3	6	1	10	73
Total animal food	1.54	3.6	16	91	17	942
VEGETABLE FOOD.						
Cereals: Corn meal, 13 pounds, 16 cents (33); flour, wheat, 24 pounds, 58 cents (37)	.74	1.7	36	8	288	1,367
Sugars, starches, etc.: Molasses, 1.5 pounds, 5 cents (43); sugar, granulated, 2 pounds, 12 cents (45)	.17	.4	....	....	32	128
Vegetables: Cabbage, 7 pounds, 14 cents (51); cowpeas, Clay, dried, 2 pounds, 6 cents (55); peas, canned, 5 pounds 30 cents (59)	.50	1.1	8	1	22	129
Fruits, etc.: Huckleberries, canned, 4 pounds, 28 cents (85); watermelon preserves, 4 pounds, 40 cents (89)	.68	1.6	....	1	38	161
Total vegetable food	2.09	4.8	44	10	380	1,785
Total food	3.63	8.4	60	101	397	2,727
Food wasted			1	1	8	45
Food actually eaten	3.63	8.4	59	100	389	2,682

The table shows a diet considerably varied in kind, but very small as regards amounts of protein and energy furnished. The cost is slightly below the average. The amount of protein furnished is unquestionably much lower than that found in other studies of families under similar conditions. The amounts of nutrients wasted, 1 gram protein, 1 gram fat, and 8 grams carbohydrates per man per day are very small. It may be that for some reason the diet was lower than usual during the period of the study, and that these figures do not represent the normal food supply. If they are correct, the family must have been decidedly undernourished.

DIETARY STUDY No. 614.

This study was made with the family of a railroad section hand. Their income was $1 per day. They paid $2.50 per month rent for the small three-room house which they occupied. They dressed poorly and saved no money.

The study began December 22, 1902. The usual data concerning the members of the family, and the number of meals taken, are given below:

	Meals.
Man, age 21 years, weight 150 pounds	42
Woman, age 21 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Two women (4 meals × 0.8 meal of man), equivalent to	3
Boy, age 2 years, weight 39 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	96

Equivalent to 1 man for 32 days.

Weights and cost of food and nutrients in dietary study No. 614.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Chuck ribs, 4 pounds, 20 cents (8); lard, 1 pound, 10 cents (12); salt, fat, 2 pounds, 20 cents (14); sausage, 6.5 pounds, 65 cents (16)	*Dollars.* 1.15	*Cents.* 3.6	*Grams.* 21	*Grams.* 93	*Grams.*	*Calories.* 911
Eggs, 0.5 pound, 5 cents (20)	.05	.2	1	1		13
Butter, 2.5 pounds, 50 cents (21)	.50	1.5	1	29		262
Buttermilk, 15 pounds, 9 cents (25)	.09	.3	6	1	7	61
Milk, skimmed, 4 pounds, 3 cents (31)	.03	.1	2		3	20
Total animal food	1.82	5.7	31	124	10	1,267

Weights and cost of food and nutrients in dietary study No. 614—Continued.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
VEGETABLE FOOD.						
Cereals: Corn meal, 17 pounds, 20 cents (33); flour, wheat, 18 pounds, 43 cents (37)	*Dollars.* 0.63	*Cents.* 2.0	*Grams.* 44	*Grams.* 13	*Grams.* 357	*Calories.* 1,720
Sugars, starches, etc.: Sugar, granulated, 3 pounds, 18 cents (45)	.18	.5			43	172
Vegetables: Beans, dried, 3.5 pounds, 18 cents (48); cucumber pickles, 0.5 pound, 5 cents (61); potatoes, 23 per cent refuse, 13 pounds, 16 cents (62); sweet potatoes, 25 per cent refuse, 16 pounds, 16 cents (68)	.55	1.7	16	2	104	498
Total vegetable food	1.36	4.2	60	15	504	2,390
Total food	3.18	9.9	91	139	514	3,657
Food wasted			3	2	17	98
Food actually eaten	3.18	9.9	88	137	497	3,559

The diet of this family as shown above is rather low in protein and high in energy, i. e., it is not a well-balanced diet. This peculiarity is more frequently noticed in the southern than in the northern States, and is probably due to the quantities of salt pork consumed. In this study, for example, pork furnished 68 per cent of the fat of the total food. The cost of the diet is not far from the average for this group of studies. The protein consumption is below the standard for man at light to moderate muscular work.

DIETARY STUDY No. 615.

This dietary study was made with a family of six, a man, wife, three girls, and an infant. The father was a bricklayer, but could not get work at his regular trade. He did work of any kind, earning on the average about 75 cents per day. They owned the house in which they lived and raised on their land some vegetables for their own use. Nearly all their food was cooked by frying.

This study began January 5, 1903. The members of the family, with ages, weights, and number of meals taken, were as follows:

	Meals.
Man, age 24 years, weight 160 pounds	42
Woman, age 26 years, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 6 years, weight 70 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 4 years, weight 46 pounds (42 meals × 0.4 meal of man), equivalent to	17
Girl, age 2 years, weight 30 pounds (42 meals × 0.4 meal of man), equivalent to	17
Man, visitor	1
Girl, visitor, age 11 years (1 meal × 0.6 meal of man), equivalent to	1
Total number of meals equivalent to	133

Equivalent to 1 man for 44 days.

Weights and cost of food and nutrients in dietary study No. 615.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Chuck ribs, 3 pounds, 15 cents (8); lard, 2.5 pounds, 25 cents (12); salt, fat, 2 pounds, 20 cents (14)	*Dollars.* 0.60	*Cents.* 1.4	*Grams.* 6	*Grams.* 49	*Grams.*	*Calories.* 460
Butter, 2 pounds, 40 cents (21)	.40	.9	....	17	....	151
Total animal food	1.00	2.3	6	66	....	611
VEGETABLE FOOD.						
Cereals: Corn meal, 10 pounds, 12 cents (33); flour, wheat, 35 pounds, 84 cents (37)	.96	2.2	44	8	348	1,639
Sugars, starches, etc.: Molasses, 9 pounds, 27 cents (43); sugar, granulated, 2 pounds, 12 cents (45)	.39	.9	2	....	85	348
Vegetables: Sweet potatoes, 30 per cent refuse, 5 pounds, 5 cents (68)	.05	.1	1	....	10	44
Total vegetable food	1.40	3.2	47	8	443	2,031
Total food	2.40	5.5	53	74	443	2,642
Food wasted	....	....	1	....	3	16
Food actually eaten	2.40	5.5	52	74	440	2,626

From the above table it will be seen that the amounts of nutrients consumed were protein 52 grams, fat 74 grams, and carbohydrates 440 grams, with a total of 2,626 calories of energy. The cost, 5.5 cents, is extremely small. It is not to be wondered that even using the cheapest foods this family was unable to procure more nourishment at so small a cost.

The waste was very small, even for these studies, showing that almost nothing of food value was unused.

The 40 cents spent for butter in this study might perhaps have been more advantageously spent for dried beans, which would have increased the protein considerably.

So far as can be judged from other dietaries, the nutrients and energy consumed by this family were insufficient for their bodily needs; nevertheless, the weights given for all the children are noticeably above the normal.

DIETARY STUDY No. 616.

This study was made with a day laborer's family. Both the parents contributed to the support of the family, their combined income being about $6 per week. They raised a considerable quantity of vegetables, which helped to reduce their food expense. They also raised some chickens and kept a pig. The house, for which the family paid $2 per month rent, had but two rooms.

The study began January 5, 1903. The members of the family, with ages, weights, and number of meals taken, follow.

	Meals.
Man, age 53 years, weight 160 pounds	42
Woman, age 53 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 11 years, weight 75 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 4 years, weight 38 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	118

Equivalent to 1 man for 39 days.

Weights and cost of food and nutrients in dietary study No. 616.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shoulder clod, 2 pounds, 20 cents (4)	0.20	0.5	4	1		25
Pork: Chuck ribs, 4 pounds, 20 cents (8); lard, 2 pounds, 20 cents (12); sausage, 1 pound, 10 cents (16)	.50	1.3	8	41		397
Buttermilk, 16 pounds, 10 cents (25)	.10	.3	6	1	6	57
Milk, skimmed, 6 pounds, 5 cents (31)	.05	.1	2		4	24
Total animal food	.85	2.2	20	43	10	503
VEGETABLE FOOD.						
Cereals: Corn meal, 8 pounds, 10 cents (33); flour, wheat, 40 pounds, 96 cents (37)	1.06	2.7	54	9	423	1,988
Vegetables: Beans, dried, 2 pounds, 10 cents (48); potatoes, 38 per cent refuse, 6.5 pounds, 8 cents (62); pumpkin, 29 pounds, 29 cents (63); sweet potatoes, 38 per cent refuse, 8 pounds, 8 cents (68)	.55	1.4	9	1	48	237
Total vegetable food	1.61	4.1	63	10	471	2,225
Total food	2.46	6.3	83	53	481	2,728
Food wasted			2	1	9	53
Food actually eaten	2.46	6.3	81	52	472	2,675

From the above table it appears that the food eaten yielded per man per day 81 grams protein, 52 grams fat, and 472 grams carbohydrates, with a fuel value of 2,675 calories. The energy figure is 27 per cent below the average for these studies. It therefore appears evident that this family was insufficiently nourished in respect to energy.

The cost is very low, and the diet shows very little variation. It would appear that the expenditure of 29 cents for pumpkin, which furnished only a very small amount of nutriment, was unwise if strict economy was necessary.

DIETARY STUDY No. 617.

This dietary study was made with a woman and her daughter, who were supported mainly by the labor of the daughter, a factory hand. They were apparently industrious people, and though the mother did

not do outside work, she had the care of the live stock, pigs, ducks, chickens, and cows, which probably contributed considerably toward the support of the family. The family occupied a four-room house, for which they paid a monthly rental of $2.

This study began January 7, 1903. The number of meals taken by these people, together with their ages and weights, are given below:

	Meals.
Woman, age 47 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 14 years, weight 120 pounds (42 meals × 0.7 meal of man), equivalent to	29
Total number of meals equivalent to	63

Equivalent to 1 man for 21 days.

Weights and cost of food and nutrients in dietary study No. 617.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Shoulder, 1 pound, 13 cents (10); lard, 2 pounds, 20 cents (12); salt, fat, 1 pound, 10 cents (14); sausage, 0.5 pound, 8 cents (16)	*Dollars.* 0.51	*Cents.* 2.4	*Grams.* 6	*Grams.* 70	*Grams.*	*Calories.* 647
Butter, 1 pound, 20 cents (21)	.20	1.0		18		160
Total animal food	.71	3.4	6	88		807
VEGETABLE FOOD.						
Cereals: Corn meal, 5 pounds, 6 cents (33); flour, wheat, 24 pounds, 58 cents (37)	.64	3.0	60	10	475	2,229
Sugars, starches, etc.: Sugar, granulated, 2 pounds, 12 cents (45)	.12	.6			43	172
Vegetables: Sweet potatoes, 25 per cent refuse, 8 pounds, 8 cents (68)	.08	.4	2	1	35	157
Fruits, etc.: Jelly, apple, 2 pounds, 20 cents (76); blackberries, canned, 3 pounds, 21 cents (78); peaches, canned, 3 pounds, 21 cents (88)	.62	2.9	2	1	77	325
Total vegetable food	1.46	6.9	64	12	630	2,883
Total food	2.17	10.3	70	100	630	3,690
Food wasted			1	1	8	45
Food actually eaten	2.17	10.3	69	99	622	3,645

The above table shows that the nutrients and energy consumed by this family amounted to 69 grams protein, 99 grams fat, and 622 grams carbohydrates, with a fuel value of 3,645 calories of energy. The cost was equivalent to 10.3 cents per man per day. From these results it will be seen that the proportion of nutrients derived from the food was small as compared with the outlay. A comparison of these data with the standard or with the average for these studies indicates that this family did not receive sufficient protein for their bodily needs. The amount of energy was comparatively high and was in all probability amply sufficient.

DIETARY STUDY No. 618.

Dietary study No. 618 was made with two persons, a boy and his grandmother. Neither had any particular occupation. The only regular income which they seemed to have had was a small sum from the rental of a little house and lot owned by the grandmother. They were very poor.

The study began January 12, 1903. The ages and weights of the subjects, together with the number of meals taken by each, are given below:

	Meals.
Boy, age 15 years, weight 90 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 67 years, weight 170 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	68

Equivalent to 1 man for 23 days.

Weights and cost of food and nutrients in dietary study No. 618.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 1 pound, 10 cents (12); salt, fat, 2 pounds, 20 cents (14); sausage, 2 pounds, 20 cents (16)	*Dollars.* 0.50	*Cents.* 2.2	*Grams.* 8	*Grams.* 67	*Grams.*	*Calories.* 628
Butter, 1 pound, 20 cents (21)	.20	.9	......	16	......	142
Buttermilk, 2 pounds, 1 cent (25)	.01	......	1	......	1	8
Milk, skimmed, 4 pounds, 3 cents (31)	.03	.1	3	......	4	28
Total animal food	.74	3.2	12	83	5	806
VEGETABLE FOOD.						
Cereals: Corn meal, 17 pounds, 20 cents (33); hominy, 7 pounds, 7 cents (34); flour, wheat, 16 pounds, 38 cents (37)	.65	2.8	68	18	576	2,736
Sugars, starches, etc.: Molasses, 2 pounds, 6 cents (43)	.06	.3	1	......	27	112
Vegetables: Cabbage, 1 pound, 2 cents (51); cowpeas, Clay, dried, 1.5 pounds, 5 cents (55)	.07	.3	7	1	19	113
Total vegetable food	.78	3.4	76	19	622	2,961
Total food	1.52	6.6	88	102	627	3,767
Food wasted	......	......	5	3	29	162
Food actually eaten	1.52	6.6	83	99	598	3,605

From the above table it will be seen that the articles of food consumed during the time of this study were extremely few. The cost, 6.6 cents per day, was very small. It seems fairly certain that the energy value is too high and the protein value slightly low for the bodily activity of the subjects, though they probably did but slight muscular work.

DIETARY STUDY No. 619.

This study was made with a widow and her four children. Not much is known of their income or activity, or their condition in general.

The study began January 12, 1903. The following data give the character of the several members of the family, with the number of meals taken by each member:

	Meals.
Woman, age 29 years, weight 135 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 8 years, weight 65 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 6 years, weight 45 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 4 years, weight 39 pounds (42 meals × 0.4 meal of man), equivalent to	17
Girl, age 1 year, weight 15 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	106

Equivalent to 1 man for 35 days.

Weights and cost of food and nutrients in dietary study No. 619.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Pork: Lard, 1 pound, 10 cents (12)	0.10	0.3		13		116
Total animal food	.10	.3		13		116
VEGETABLE FOOD.						
Cereals: Corn meal, 10 pounds, 12 cents (33); hominy, 2 pounds, 2 cents (34); rolled oats, 3 pounds, 15 cents (35); flour, wheat, 36 pounds, 86 cents (37)	1.15	3.3	65	13	495	2,356
Sugars, starches, etc.: Molasses, 5 pounds, 13 cents (43); sugar, granulated, 3 pounds, 18 cents (45)	.31	.9	2		84	344
Vegetables: Cabbage, 3 pounds, 6 cents (51); onions, 0.5 pound, 1 cent (57); parsnips, 2 pounds, 2 cents (60); sweet potatoes, 25 per cent refuse, 8 pounds, 8 cents (68); turnips, 14 pounds 7 cents (71)	.24	.7	4	1	37	172
Total vegetable food	1.70	4.9	71	14	616	2,872
Total food	1.80	5.2	71	27	616	2,988
Food wasted			1	1	9	49
Food actually eaten	1.80	5.2	70	26	607	2,939

The table above shows the total expenditure for the two weeks of this study to have been \$1.80, or 5.2 cents per man per day. Only three studies of this series surpass this one in the cheapness of the food. This family were practically vegetarians at the time of the

study, the only animal food consumed being 1 pound of lard. Their diet might be compared with that in other studies with vegetarians,[a] though the latter adopted their peculiar food from choice and this family mainly from necessity. The weight of the older children is not far from normal, but the baby is noticeably underweight.

DIETARY STUDY No. 620.

This study was made with the family of a day laborer, but the nature of his work is not stated. His wife helped to support the family by sewing, for which she received a few dollars per month. One of the boys worked in a sawmill, earning $1 a day. They owned the house which they occupied.

This study began February 2, 1903. The usual data concerning the family are given below:

	Meals.
Man, age 31 years, weight 150 pounds	42
Woman, age 48 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 31 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 14 years, weight 85 pounds (42 meals × 0.8 meal of man), equivalent to	33
Girl, age 7 years, weight 50 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 6 years, weight 60 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 4 years, weight 38 pounds (42 meals × 0.4 meal of man), equivalent to	17
Boy, age 5 months, weight 18 pounds (42 meals × 0.3 meal of man), equivalent to	13
Woman, visitor (6 meals × 0.8 meal of man), equivalent to	5
Total number of meals equivalent to	220

Equivalent to 1 man for 73 days.

Weights and cost of food and nutrients in dietary study No. 620.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shoulder clod, 2 pounds, 20 cents (4)	0.20	0.3	2	1	....	17
Pork: Lard, 5 pounds, 50 cents (12); salt, fat, 11.5 pounds, $1.15 (14)	1.65	2.2	6	83	....	763
Butter, 1 pound, 20 cents (21)	.20	.3	....	5	....	44
Buttermilk, 24 pounds, 15 cents (25)	.15	.2	4	1	5	45
Total animal food	2.20	3.0	12	90	5	869

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 107 and 132.

Weights and cost of food and nutrients in dietary study No. 620—Continued.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
VEGETABLE FOOD.						
Cereals: Corn meal, 24 pounds, 29 cents (33); hominy, 5 pounds, 5 cents (34); flour, wheat, 73 pounds, $1.75 (37)	*Dollars.* 2.09	*Cents.* 2.9	*Grams.* 60	*Grams.* 11	*Grams.* 476	*Calories.* 2,242
Sugars, starches, etc.: Sugar, granulated, 10 pounds, 60 cents (45)	.60	.8	....	....	62	248
Vegetables: Cabbage, 10 pounds, 20 cents (51); onions, 10 pounds, 18 cents (57); potatoes, 40 per cent refuse, 16 pounds, 20 cents (62); sauerkraut, 4 pounds, 8 cents (67); sweet potatoes, 30 per cent refuse, 8 pounds, 8 cents (68); tomatoes, canned, 4 pounds, 20 cents (70); turnips, 4 pounds, 2 cents (71)	.96	1.3	5	1	33	161
Fruits, etc.: Blackberries, canned, 15 pounds, $1.05 (78); huckleberries, canned, 4 pounds, 8 cents (85); peaches, canned, 10 pounds, 70 cents (88); watermelon preserves, 2 pounds, 20 cents (89)	2.03	2.8	1	2	72	310
Total vegetable food	5.68	7.8	66	14	643	2,961
Total food	7.88	10.8	78	104	648	3,830
Food wasted	....	....	1	1	13	65
Food actually eaten	7.88	10.8	77	103	635	3,765

The table above shows that this family received a diet of much greater variety than the most of those reported in this series. Particularly is this true of the vegetables and fruits, which represent 38 per cent of the total expenditure for food. The food supplied 77 grams protein, 103 grams fat, 635 grams of carbohydrates, and 3,765 calories of energy per man per day. These figures show a one-sided diet with high energy and low protein values. This condition could apparently have been much improved by the purchase of more meats, such as round steaks, and of less fruit, though undoubtedly fruits are healthful, if expensive foods. It seems very certain that the diet supplied sufficient energy but insufficient protein. The cost, 10.8 cents per man per day, is somewhat above the average for these studies.

DIETARY STUDY No. 621.

Dietary study No. 621 was made with the family of a man engaged in two separate occupations, namely, farming, which occupied about half the year, and teaching school the balance of his time. His income from farming is unknown. During the months in which he taught school his salary was $23 per month.

The study began November 24, 1902. The members of the family, with ages, weights, and number of meals taken, are as follows.

	Meals.
Man, age 23, weight 145 pounds	42
Woman, age 21, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	34
Three men, visitors	8
Two women, visitors (3 meals × 0.8 meal of man), equivalent to	2
Girl, visitor, age 14 years (1 meal × 0.7 meal of man), equivalent to	1
Girl, visitor, age 12 years (1 meal × 0.6 meal of man), equivalent to	1
Total number of meals equivalent to	88

Equivalent to 1 man for 29 days.

Weights and cost of food and nutrients in dietary study No. 621.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Butter, 3.25 pounds, 65 cents (21)	0.65	2.2	1	42		378
Milk, 10 pounds, 25 cents (24)	.25	.9	5	5	8	96
Buttermilk, 30 pounds, 19 cents (25)	.19	.7	14	3	16	147
Total animal food	1.09	3.8	20	50	24	621
VEGETABLE FOOD.						
Cereals: Corn meal, 24 pounds, 29 cents (33); rice, 1 pound, 6 cents (36); flour, wheat, 20 pounds, 48 cents (37)	.83	2.9	61	19	503	2,425
Sugars, starches, etc.: Sugar, granulated, 2.5 pounds, 15 cents (45)	.15	.5			39	156
Vegetables: Beans, dried, 2 pounds, 10 cents (48); beans, pickled, 6.5 pounds, 33 cents (49); beets, pickled, 1 pound, 5 cents (50); cabbage, 11 pounds, 22 cents (51); onions, 0.25 pound, 1 cent (57); potatoes, 13 per cent refuse, 2 pounds, 3 cents (62)	.74	2.5	11	1	40	213
Fruits, etc.: Gooseberries, canned, 0.25 pound, 2 cents (83); peaches, canned, 12 pounds, 84 cents (88)	.86	3.0	1		21	88
Total vegetable food	2.58	8.9	73	20	603	2,882
Total food	3.67	12.7	93	70	627	3,503
Food wasted			3	1	21	105
Food actually eaten	3.67	12.7	90	69	606	3,398

The nutrients daily consumed by this family during the time of this study were as follows: Protein 90 grams, fat 69 grams, and carbohydrates 606 grams. The fuel value was, therefore, 3,398 calories. The cost, as compared with the other studies, is about 4 cents above the average. The waste in this study, though not large as compared with studies in other localities, is somewhat larger than the average of these studies. Considering the comparatively light muscular work probably done by both the man and the woman, the protein was probably nearly adequate to their needs, and the energy perhaps excessive.

DIETARY STUDY No. 622.

Dietary study No. 622 reports the results of a study with a farmer's family, living near the Smoky Mountains. At the time of the study the man was not working on the farm, but was in a sawmill. From the data reported, it would appear that this man owned a considerable tract of lumber and some stock. He and his wife are described as industrious, hard-working people. Their income is not known.

This study began December 9, 1902. The usual data pertaining to the family are summarized as follows:

	Meals.
Man, age 35 years, weight 165 pounds	42
Woman, age 35 years, weight 115 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 10 years, weight 65 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 8 years, weight 50 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 6 years, weight 40 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 2 years, weight 30 pounds (42 meals × 0.4 meal of man), equivalent to	17
Man, visitor	2
Total number of meals equivalent to	162

Equivalent to 1 man for 54 days.

Weights and cost of food and nutrients in dietary study No. 622.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork, salt, fat, 16.75 pounds, $1.68 (14)	1.68	3.1	11	103		961
Butter, 0.5 pound, 10 cents (21)	.10	.2		4		35
Milk, 58 pounds, $1.45 (24)	1.45	2.7	16	17	25	315
Total animal food	3.23	6.0	27	124	25	1,311
VEGETABLE FOOD.						
Cereal, corn meal, 77 pounds, 92 cents (33)	.92	1.7	49	27	426	2,140
Sugars, starches, etc.: Molasses, 5 pounds, 15 cents, (43)	.15	.3	1		29	120
Vegetables: Beans, dried, 13 pounds, 65 cents (48); beets, pickled, 5 pounds, 25 cents (50); sauerkraut, 9 pounds, 18 cents (67); sweet potatoes, 13 per cent refuse, 57 pounds, 57 cents (68)	1.65	3.0	31	5	189	925
Total vegetable food	2.72	5.0	81	32	644	3,185
Total food	5.95	11.0	108	156	669	4,496
Food wasted			1	1	15	73
Food actually eaten	5.95	11.0	107	155	654	4,423

The amounts of nutrients and energy consumed during the time of this study were 107 grams protein, 155 grams fat, 654 grams carbohydrates, and 4,423 calories of energy. It seems not unlikely that the excess of energy was consumed by the man, whose work may

have been quite severe, and that the protein may have been slightly low.

The nutritive value of the diet as compared with the other studies made here, is much above the average. The cost, 11 cents, is also above the average for these studies, and seems especially high when it is realized that there was almost no variety in the diet.

DIETARY STUDY No. 623.

Dietary study No. 623 was made with the family of a miller. They own the property on which they live, and also the gristmill. A part of the land is rented, a certain proportion of the crop being paid in place of rent. Their income is not stated.

The study began January 3, 1903. The members of the family, with ages, weights, and number of meals taken, are given below:

<table>
<tr><th colspan="2"></th><th>Meals.</th></tr>
<tr><td colspan="2">Man, age 38, weight 180 pounds</td><td>37</td></tr>
<tr><td colspan="2">Woman, age 29 years, weight 110 pounds (42 meals × 0.8 meal of man), equivalent to</td><td>34</td></tr>
<tr><td colspan="2">Woman, age 25 years, weight 150 pounds (42 meals × 0.8 meal of man), equivalent to</td><td>34</td></tr>
<tr><td colspan="2">Man, visitor</td><td>5</td></tr>
<tr><td>Woman, visitor
Boy, visitor, age 15 years
Boy, visitor, age 14 years</td><td>(3 meals × 0.8 meal of man) equivalent to</td><td>2</td></tr>
<tr><td colspan="2">Total number of meals equivalent to</td><td>112</td></tr>
</table>

Equivalent to 1 man for 37 days.

Weights and cost of food and nutrients in dietary study No. 623.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Salt, fat, 13.5 pounds, $1.35 (14); sausage, 4 pounds, 40 cents (16)	*Dollars.* 1.75	*Cents.* 4.7	*Grams.* 19	*Grams.* 144	*Grams.*	*Calories.* 1,358
Butter, 4 pounds, 80 cents (21)	.80	2.2	1	41	....	369
Milk, 34 pounds, 85 cents (24)	.85	2.3	13	15	21	269
Buttermilk, 4 pounds, 3 cents (25)	.03	.1	2	....	2	16
Total animal food	3.43	9.3	35	200	23	2,012
VEGETABLE FOOD.						
Cereals: Corn meal, 38 pounds, 46 cents (33); flour, wheat, 16 pounds, 38 cents (37)	.84	2.2	55	22	460	2,256
Sugars, starches, etc.: Honey, 1.5 pounds, 15 cents (42)	.15	.4	...		15	60
Vegetables: Cabbage, 18 pounds, 36 cents (51); parsnips, 1 pound, 1 cent (60); pumpkin, dried, 1 pound, 5 cents (64); sweet potatoes, 11 per cent refuse, 35 pounds, 35 cents (68)	.77	2.1	11	3	126	575
Fruits, etc.: Apples, dried, 1 pound, 5 cents (74); gooseberries, canned, 0.25 pound, 2 cents (83); grapes, canned, 0.5 pound, 4 cents (84)	.11	.3			9	36
Total vegetable food	1.87	5.0	66	25	610	2,927
Total food	5.30	14.3	101	225	633	4,939
Food wasted	....	....	2	1	17	85
Food actually eaten	5.30	14.3	99	224	616	4,854

The table above shows that the food consumption of this family, on the per man per day basis, was 99 grams protein, 224 grams fat, and 616 grams carbohydrates, with a fuel value of 4,854 calories. This amount of energy is extremely high, not only as compared with the average of these studies, but also as compared with studies in other localities. The protein is above the average for these studies. The cost, 14.3 cents, is, with but two exceptions, the maximum for these studies.

It is noticeable in this study that while 65 per cent of the total amount paid for food was expended for animal food, the protein and energy obtained were only 35 and 41 per cent, respectively, of the total. This was due largely to the amount of butter consumed. Corn meal and salt pork were the two principal foods.

DIETARY STUDY No. 624.

This study was made with a farmer's family. From the data reported it would appear that they were respectable, hard-working people. They owned some live stock, and were apparently in fair circumstances as compared with other families in this series. Their house, however, appears to have been of the simplest.

The study began January 3, 1903. The usual data concerning the family, and the number of meals taken by each, are given below:

	Meals.
Man, age 47 years, weight 135 pounds	40
Man, age 18 years, weight 175 pounds	40
Man, age 23 years, weight 140 pounds	39
Woman, age 45 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 23 years, weight 122 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 14 years, weight 80 pounds (42 meals × 0.8 meal of man), equivalent to	33
Girl, age 12 years, weight 75 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 9 years, weight 60 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 7 years, weight 60 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 5 years, weight 45 pounds (42 meals × 0.4 meal of man), equivalent to	17
Girl, age 2 years, weight 25 pounds (42 meals × 0.4 meal of man), equivalent to	17
Three men, visitors	3
Two women, visitors (2 meals × 0.8 meal of man), equivalent to	2
Total number of meals equivalent to	326

Equivalent to 1 man for 108 days.

Weights and cost of food and nutrients in dietary study No. 624.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Shoulder, salt, 23.5 pounds, $2.35 (15); sausage, 5.5 pounds, 55 cents (16)	2.90	2.7	15	43		443
Butter, 4 pounds, 80 cents (21)	.80	.7		14		124
Milk, 114 pounds, $2.85 (24)	2.85	2.7	15	17	25	311
Buttermilk, 93 pounds, 58 cents (25)	.58	.5	12	2	13	118
Total animal food	7.13	6.6	42	76	38	996
VEGETABLE FOOD.						
Cereals: Corn meal, 122 pounds, $1.46 (33); flour, wheat, 20 pounds, 48 cents (37)	1.94	1.8	47	22	403	1,996
Sugars, starches, etc.: Molasses, 2.5 pounds, 8 cents (43)	.08	.1			7	28
Vegetables: Beans, dried, 8.5 pounds, 43 cents (48); cabbage, 10.5 pounds, 21 cents (51); potatoes, 10 per cent refuse, 5 pounds, 6 cents (62); sauerkraut, 2.25 pounds, 5 cents (67); sweet potatoes, 11 per cent refuse, 53 pounds, 53 cents (66); turnips, 3 pounds, 2 cents (71)	1.30	1.2	12	2	84	402
Fruits, etc.: Apples, 10 pounds, 20 cents (73); apples, dried, 4 pounds, 20 cents (74); apple butter, 2 pounds, 20 cents (77); grapes, canned, 4.5 pounds, 32 cents (84)	.92	.8	1	1	21	97
Total vegetable food	4.24	3.9	60	25	515	2,523
Total food	11.37	10.5	102	101	553	3,519
Food wasted			1		6	28
Food actually eaten	11.37	10.5	101	101	547	3,491

The diet of this family furnished 101 grams protein, 101 grams fat, 547 grams carbohydrates, and 3,491 calories of energy per man per day. The cost was 10.5 cents. From what is known of the conditions of this family, it seems fair to suppose that they had as much food as they desired. It would be expected that in the winter season, when this study was made, the muscular work of the men would be less than in the farming season. Inasmuch, however, as the observer speaks particularly of the family as being hard workers, it may be that the protein and energy furnished by the diet were no more than adequate. Compared with those observed in many of the other studies, they are generous.

DIETARY STUDY No. 625.

Dietary study No. 625 was made with the family of a farmer. His income is not known; he owned considerable live stock.

The study began January 24, 1903. The members of the family, with ages, weights, and number of meals taken, are as follows:

	Meals.
Man, age 48 years, weight 180 pounds	42
Woman, age 40 years, weight 140 pounds (35 meals × 0.8 meal of man), equivalent to	28
Girl, age 16 years, weight 135 pounds (29 meals × 0.8 meal of man), equivalent to	23

	Meals.
Boy, age 13 years, weight 100 pounds (41 meals × 0.8 meal of man), equivalent to	33
Boy, age 11 years, weight 80 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 7 years, weight 50 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 2 years, weight 25 pounds (42 meals × 0.4 meal of man), equivalent to	17
Man, visitor	1
Woman, visitor (1 meal × 0.8 meal of man), equivalent to	1
Total number of meals equivalent to	191

Equivalent to 1 man for 64 days.

Weights and cost of food and nutrients in dietary study No. 625.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Salt, fat, 27 pounds, $2.70 (14)	2.70	4.2	15	140		1,306
Butter, 5.5 pounds, $1.10 (21)	1.10	1.7	1	32		289
Milk, 113 pounds, $2.83 (24)	2.83	4.4	26	28	41	517
Buttermilk, 48.5 pounds, 30 cents (25)	.30	.5	10	2	12	106
Total animal food	6.93	10.8	52	202	53	2,218
VEGETABLE FOOD.						
Cereals: Corn meal, 66.5 pounds, 80 cents (33); flour, wheat, 10 pounds, 24 cents (37)	1.04	1.7	42	21	365	1,815
Sugars, starches, etc.: Molasses, 4 pounds, 10 cents (43); sugar, granulated, 1 pound, 6 cents (45)	.16	.2	1		27	112
Vegetables: Beans, dried, 13.5 pounds, 68 cents (48); beans, pickled, 0.5 pound, 3 cents (49); cabbage, 18 pounds, 36 cents (51); potatoes, 12 per cent refuse, 4 pounds, 5 cents (62); sauerkraut, 4 pounds, 8 cents (67); sweet potatoes, 8 per cent refuse, 52 pounds, 52 cents (68)	1.72	2.7	29	4	166	815
Fruits, etc.: Apples, dried, 1.5 pounds, 8 cents (74); apples, canned, 1 pound, 10 cents (78); apple butter, 0.75 pound, 8 cents (77); gooseberries, canned, 1 pound, 7 cents (83)	.33	.5		1	14	65
Total vegetable food	3.25	5.1	72	26	572	2,807
Total food	10.18	15.9	124	228	625	5,025
Food wasted			2	1	20	97
Food actually eaten	10.18	15.9	122	227	605	4,928

The table above shows a ration yielding about 20 grams more protein than that called for by the standard for a man at moderate muscular work, with an amount of energy considerably above that required by the standard for a man at hard work. The three older children are considerably heavier than the majority at their ages, and the two younger ones are of about normal weight. If the children were reckoned as adults (which would perhaps be fair), the computed protein and energy consumption per person per day would be somewhat smaller. There was no doubt that this family was well nourished. The cost of the daily food, 15.9 cents per man per day, is next to the highest among these studies. The diet as regards vegetable food is fairly varied, but not as regards animal food.

Milk was extensively used, yielding more than 20 per cent of the total protein. The usual corn meal and salt pork were also used very largely.

DIETARY STUDY No. 626.

This study was made with the family of a farmer. At the time of this study, however, he was at work cutting timber from land which he owned. The home was near the Smoky Mountains. It is not known what the family income amounted to.

The study began January 31, 1903. The usual data are given below:

	Meals.
Man, age 23 years, weight 145 pounds	42
Woman, age 19 years, weight 114 pounds (40 meals × 0.8 meal of man), equivalent to	32
Man, visitor	7
Two women, visitors (2 meals × 0.8 meal of man), equivalent to	2
Total number of meals equivalent to	83

Equivalent to 1 man for 28 days.

Weights and cost of food and nutrients in dietary study No. 626.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 8.5 pounds, 85 cents (12); salt, fat, 8 pounds, 80 cents (14)	1.65	5.9	10	233		2,114
Butter, 2.5 pounds, 50 cents (21)	.50	1.8	1	33		297
Milk, 72 pounds, $1.80 (24)	1.80	6.4	37	41	60	753
Buttermilk, 19.5 pounds, 12 cents (25)	.12	.4	10	2	11	102
Total animal food	4.07	14.5	58	309	71	3,266
VEGETABLE FOOD.						
Cereals: Corn meal, 25 pounds, 30 cents (33); rice, 0.25 pound, 2 cents (36); flour, wheat, 18 pounds, 43 cents (37)	.75	2.7	60	20	497	2,406
Sugars, starches, etc.: Molasses, 3 pounds, 9 cents (43); sugar, granulated, 1.5 pounds, 9 cents (45)	.18	.6	1		58	236
Vegetables: Beans, dried, 0.5 pound, 2 cents (48); beans, pickled, 3.5 pounds, 18 cents (49); cabbage, 6.5 pounds, 13 cents (51); potatoes, 36 per cent refuse, 2.75 pounds, 3 cents (62); pumpkin butter, 2.5 pounds, 20 cents (65); sauerkraut, 1.5 pounds, 3 cents (67); turnips, 2 pounds, 1 cent (71)	.60	2.1	6	1	24	129
Fruits, etc.: Apples, dried, 6.25 pounds, 31 cents (74); apple butter, 2 pounds, 20 cents (77); blackberries, dried, 1 pound, 5 cents (79); citron, 0.25 pound, 3 cents (81); gooseberries, dried, 1.5 pounds, 8 cents (82); gooseberries, canned, 3 pounds, 21 cents (83); grapes, canned, 2.5 pounds, 18 cents (84); huckleberries, canned, 2 pounds, 14 cents (85)	1.20	4.3	3	4	127	556
Total vegetable food	2.73	9.7	70	25	706	3,327
Total food	6.80	24.2	128	334	777	6,593
Food wasted			4	2	34	170
Food actually eaten	6.80	24.2	124	332	743	6,423

The data of the above table show a diet peculiar in that there was a considerable variety of vegetables and fruits consumed. The animal food, however, lacked a corresponding variety, consisting entirely of pork and dairy products. Some of the vegetables and fruits appear to be peculiar to this locality, analyses of them not having been heretofore reported. Such are pumpkin butter, dried blackberries, and gooseberries. The diet in this study furnished fully sufficient amounts of nutrients. The energy is very high, and represents the maximum for this series of studies. The cost, 24.2 cents per day, is also the maximum, and almost three times as high as the average.

The extra cost was due to the unusual amount of fruits and vegetables used, and consequently shows an increased energy rather than in the protein. This diet resembles those ordinarily found among families in comfortable circumstances more than it does the majority of these Tennessee studies. In fact, it differs from the latter in so many respects that it can hardly be considered typical of the region, and was not included in the averages for the series.

DIETARY STUDY No. 627.

This study was made with the family of a farmer, who cultivated some 70 acres of rented land. The family occupied a log house. No statement of the income or activity of the man or his family was obtained, but it was assumed to be about that which would ordinarily be expected of a man at this occupation in the winter season, namely, light to moderate.

The study began February 7, 1903, and continued for the usual period. The ages and weights of the subjects, and the number of meals taken by each, are given below:

	Meals.
Man, age 31 years, weight 150 pounds	40
Woman, age 25 years, weight 109 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 3 years, weight 35 pounds (42 meals × 0.4 meal of man), equivalent to	17
Girl, age 5 months, weight 16 pounds (42 meals × 0.3 meal of man), equivalent to	13
Four men, visitors	6
Total number of meals equivalent to	110

Equivalent to 1 man for 37 days.

Weights and cost of food and nutrients in dietary study No. 627.

Food consumed during the entire study (14 days). Kinds and amounts.	Cost.	Cost, nutrients, and fuel value of food per man per day. Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Pork: Salt, fat, 4.75 pounds, 48 cents (14)	0.48	1.3	5	42	....	394
Game: Rabbit, 0.75 pound, 10 cents (19)	.10	.3	1	1	....	13
Total animal food	.58	1.6	6	43	....	407
VEGETABLE FOOD.						
Cereals: Corn meal, 42.5 pounds, 51 cents (33); rice, 1 pound, 6 cents (36)	.57	1.5	40	22	353	1,768
Sugars, starches, etc.: Sugar, granulated, 1 pound, 6 cents (45)	.06	.2	....	....	12	48
Vegetables: Cowpeas, Clay, dried, 5.5 pounds, 17 cents (55); potatoes, 23 per cent refuse, 12 pounds, 5 cents (62); sauerkraut, 8.75 pounds, 18 cents (67); turnips, 21 pounds, 11 cents (71).	.51	1.4	21	2	81	425
Fruits, etc.: Apples, dried, 4 pounds, 20 cents (74)	.20	.5	1	1	33	145
Total vegetable food	1.34	3.6	62	25	479	2,386
Total food	1.92	5.2	68	68	479	2,793
Food wasted	....	....	1	1	16	77
Food actually eaten	1.92	5.2	67	67	463	2,716

The table above shows that the diet furnished 67 grams protein, 67 grams fat, 463 grams carbohydrates, and 2,716 calories of energy. These amounts are much lower than would be expected, though the energy furnished is much higher in proportion than the protein. The cost, 5.2 cents per man per day, is very low, and it is not surprising that for such small expenditures so little was obtained, but rather that this family was able on such a small amount of money to obtain as much nutrients and energy as they did. It will be seen from the table that corn meal was the principal article of food and alone furnished nearly two-thirds of the total protein and energy obtained by this family. As in almost all of these studies, the waste was small.

DIETARY STUDY No. 628.

Dietary study No. 628 was made with a family of seven persons. The father is a farmer, but did also some trucking and other job work, as did also one of his sons, the other son being employed in a sawmill. The father did not have regular employment. Since the income was so irregular an accurate estimate of it is impossible. From the data obtained it would appear that the average total income of this family was about $1.25 per day. The rent paid for their home is $2 per month.

The study began February 13, 1903, and continued for fourteen days. The members of the family, with ages, weights, and number of meals taken, appear below:

	Meals.
Man, age 47 years, weight 150 pounds	42
Man, age 23 years, weight 140 pounds	42
Woman, age 46 years, weight 160 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 12 years, weight 60 pounds (42 meals × 0.6 meal of man), equivalent to	25
Girl, age 4 years, weight 20 pounds (42 meals × 0.4 meal of man), equivalent to	17
Boy, age 17 years, weight 130 pounds	42
Boy, age 6 years, weight 29 pounds (42 meals × 0.5 meal of man), equivalent to	21
Total number of meals equivalent to	223

Equivalent to 1 man for 74 days.

Weights and cost of food and nutrients in dietary study No. 628.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Chuck, 4 pounds, 40 cents (1)	0.40	0.5	4	2		34
Pork: Lard, 3 pounds, 30 cents (12); salt, fat, 8 pounds, 80 cents (14); sausage, 5 pounds, 50 cents (16)	1.60	2.2	8	69		646
Butter, 3 pounds, 60 cents (21)	.60	.8		15		133
Buttermilk, 36 pounds, 23 cents (25)	.23	.3	6	1	8	65
Total animal food	2.83	3.8	18	87	8	878
VEGETABLE FOOD.						
Cereals: Corn meal, 40 pounds, 48 cents (33); flour, wheat, 48 pounds, $1.15 (37)	1.63	2.2	48	13	390	1,868
Sugars, starches, etc.: Molasses, 5 pounds, 15 cents (43); sugar, granulated, 5 pounds, 30 cents (45)	.45	.6	1		52	212
Vegetables: Beans, dried, 6 pounds, 30 cents (48); cowpeas, Clay, dried, 3 pounds, 9 cents (55); potatoes, 30 per cent refuse, 10 pounds, 13 cents (62); sauerkraut, 8 pounds, 16 cents (67).	.68	.9	13	1	44	237
Fruits, etc.: Peaches, dried, 1 pound, 12 cents (87).	.12	.2			4	16
Total vegetable food	2.88	3.9	62	14	490	2,333
Total food	5.71	7.7	80	101	498	3,211
Food wasted			1		10	44
Food actually eaten	5.71	7.7	79	101	488	3,167

From the table above it will be seen that the food consumed yielded 79 grams protein and 3,167 calories of energy per man per day. It seems fair to suppose that the energy obtained approximated the requirements, but that the protein supplied was less than that needed. Except for the 17-year-old boy the children are decidedly under normal weight. The waste was very small. The cost, 7.7 cents per man per day, was 13 per cent less than the average for these studies. As in several other instances, pork and corn meal were predominant in the diet.

DIETARY STUDY No. 629.

Dietary study No. 629 was made with the family of a railroad employee; he was employed as a "section hand," receiving $1 per day for his work. The family occupied part of a very poor house, which had formerly been a dry kiln, paying $1 per month rent.

The study began February 13, 1903. The ages and weights of the members of the family, and the number of meals taken by each member, are given below:

	Meals.
Man, age 27 years, weight 140 pounds	42
Woman, age 30 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 1 year, weight 16 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	89

Equivalent to 1 man for 30 days.

Weights and cost of food and nutrients in dietary study No. 629.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 3 pounds, 30 cents (12); salt, fat, 7.5 pounds, 75 cents (14)	1.05	3.5	9	128		1,175
Eggs, 1.5 pounds, 15 cents (20)	.15	.5	3	2		30
Buttermilk, 56 pounds, 35 cents (25)	.35	1.2	25	5	29	260
Total animal food	1.55	5.2	37	135	29	1,465
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents (33); flour, wheat, 38 pounds, 91 cents (37)	1.15	3.8	81	18	646	3,068
Sugars, starches, etc.: Sugar, granulated, 2 pounds, 12 cents (45)	.12	.4			30	120
Vegetables: Cowpeas, Clay, dried, 6.5 pounds, 20 cents (55)	.20	.7	21	2	61	346
Fruits, etc.: Apples, dried, 3.5 pounds, 18 cents (74)	.18	.6	1	1	35	153
Total vegetable food	1.65	5.5	103	21	772	3,687
Total food	3.20	10.7	140	156	801	5,152
Food wasted			3	1	23	113
Food actually eaten	3.20	10.7	137	155	778	5,039

The data of this study as given in the table above show that the amounts of food consumed furnished abundant nutrients and energy for the maintenance of these subjects. One hundred and thirty-seven grams protein is a liberal allowance for persons with the muscular activity of these persons, and the energy, too, would appear to be sufficient. The protein supply is the maximum for these studies, while the energy is among the highest amounts observed. The diet was extremely simple, only nine articles of food (aside from condi-

ments) being used during the entire time of this study (14 days). The family ate very little meat of any kind, and 59 per cent of the protein and 60 per cent of energy was derived from the corn meal and wheat flour used. The cost of the food, 10.7 cents per man per day, is, as compared with the nutrients received, extremely small. It seems that this diet, from a pecuniary standpoint at least, was very economical

DIETARY STUDY No. 630.

This study was made with two persons, a widow and her daughter. They occupy a three-room house, which they rent for $2.50 per month, and support themselves by taking in family washing, thereby earning about $3 per week.

The study began October 5, 1903, and continued for the usual period. The age and weight of each subject, and the number of meals eaten, were as follows:

	Meals.
Woman, age 41 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 14 years, weight 97 pounds (42 meals × 0.7 meal of man), equivalent to	29
Total number of meals equivalent to	63

Equivalent to 1 man for 21 days.

Weights and cost of food and nutrients in dietary study No. 630.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Beef: Shoulder, clod, 2.13 pounds, 21 cents (4)	0.21	1.0	9	2		54
Pork: Lard, 2 pounds, 10 cents (12); salt, fat, 2.5 pounds, 25 cents (14); sausage, 3.5 pounds, 35 cents (16)	.70	3.3	13	118		1,102
Total animal food	.91	4.3	22	120		1,156
VEGETABLE FOOD.						
Cereals: Corn meal, 12.5 pounds, 15 cents (33); flour, wheat, 15.38 pounds, 37 cents (37)	.52	2.5	54	15	436	2,093
Vegetables: Cabbage, 2.5 pounds, 5 cents (51); onions, 1.5 pounds, 3 cents (57); potatoes, 20 per cent refuse, 17 pounds, 21 cents (62); sweet potatoes, 25 per cent refuse, 5 pounds, 5 cents (68); tomatoes, 3.5 pounds, 4 cents (69)	.38	1.8	9	1	79	361
Fruits, etc.: Apples, 2 pounds, 4 cents (73); muskmelons, 5 pounds, 10 cents (86)	.14	.7			10	40
Total vegetable food	1.04	5.0	63	16	525	2,494
Total food	1.95	9.3	85	136	525	3,650
Food wasted			4	1	22	113
Food actually eaten	1.95	9.3	81	135	503	3,537

The results of this study, reduced to the usual per man per day basis, show a diet low in protein and high in energy. Doubtless the energy provided was sufficient for the needs of the women, but such would not appear to be true of the protein. There was little variety in the diet, the number of articles used during the two weeks being small. It must have required much ingenuity to have made them up into cooked dishes in such a way as to prevent the food from becoming very monotonous. The cost, 9.3 cents, is relatively high for the amount and variety of food obtained.

DIETARY STUDY No. 631.

This study was made with a family of nine, seven of whom were children. The house which they occupied had seven rooms, and would appear to have been better furnished than most of those occupied by the subjects of these studies (Pl. II, fig. 1). It rented for $3.50 per month. The family was evidently economical, as it was noted that they saved some money. Their appearance was unusually neat. Their income amounted to about $2.55 per day. The father, one daughter, and two boys did factory work.

The study began October 7, 1903. The ages and weights of the several members of the family, and the number of meals taken by each, are given below:

	Meals.
Man, age 57 years, weight 160 pounds	42
Woman, age 45 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	33
Woman, age 18 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	33
Boy, age 15 years, weight 90 pounds (42 meals × 0.9 meal of man), equivalent to	38
Girl, age 13 years, weight 60 pounds (42 meals × 0.7 meal of man), equivalent to	29
Boy, age 10 years, weight 40 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 7 years, weight 30 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 6 years, weight 24 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 3 years, weight 20 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	259

Equivalent to 1 man for 86 days.

Weights and cost of food and nutrients in dietary study No. 631.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kind and amount.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shoulder clod, 2.5 pounds, 25 cents (4)	0.25	0.3	3	1	....	21
Pork: Lard, 4 pounds, 40 cents (12); salt, fat, 4 pounds, 40 cents (14); sausage, 4 pounds, 40 cents (16)	1.20	1.4	4	46	....	425
Total animal food	1.45	1.7	7	47	....	446
VEGETABLE FOOD.						
Cereals: Corn meal, 36 pounds, 43 cents (33); flour, wheat, 60 pounds, $1.44 (37)	1.87	2.2	46	11	371	1,766
Sugars, starches, etc.: Sugar, granulated, 15.5 pounds, 93 cents (45)	.93	1.1	....	....	82	328
Vegetables: Cabbage, 2.5 pounds, 5 cents (51); green corn, 6 pounds, 30 cents (52)	.35	.4	1	....	7	32
Fruits, etc.: Apples, 10 pounds, 20 cents (71)	.20	.2	....	....	6	24
Total vegetable food	3.35	3.9	47	11	466	2,150
Total food	4.80	5.6	54	58	466	2,596
Food wasted	....	....	1	....	5	24
Food actually eaten	4.80	5.6	53	58	461	2,572

The table above shows the very noticeable fact that the diet of this family was essentially vegetarian in character. Only 7 grams of protein and 446 calories of energy were derived from animal food. Corn meal was easily the most important food, while corn meal and wheat flour furnished about 85 per cent of the total protein and 68 per cent of the total energy. As regards the total nutrients consumed, it will appear that they furnished far less than the dietary standards demand, and, roughly speaking, 30 per cent less than the average for these studies. Inasmuch as this family was saving money, it seems difficult to believe that they had not food enough to eat. Nevertheless, the children are all noticeably below the average in weight. It is perhaps impossible with the data at hand to account satisfactorily for the conditions shown by this study.

DIETARY STUDY No. 632.

This study was made with a family of three persons, the man being a factory operative regularly employed and earning $1 per day.

The study was made in October, 1903. The usual data concerning the subjects of the study are given below:

	Meals.
Man, age 52 years, weight 150 pounds	42
Woman, age 28 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 5 years, weight 30 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	93

Equivalent to 1 man for 31 days.

FIG. 1.—HOME OF FAMILY NEAR MARYVILLE. DIETARY STUDY NO. 631.

FIG. 2.—HOME OF FACTORY OPERATIVE. DIETARY STUDY NO. 639.

Weights and cost of food and nutrients in dietary study No. 632.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 2 pounds, 20 cents (12); salt fat, 2 pounds, 20 cents (14); sausage, 2 pounds, 20 cents (16)	*Dollars.* 0.60	*Cents.* 1.9	*Grams.* 6	*Grams.* 65	*Grams.*	*Calories.* 602
Eggs, 2 pounds, 20 cents (20)	.20	.6	4	3		43
Butter, 2 pounds, 40 cents (21)	.40	1.3	1	24		218
Buttermilk, 12.5 pounds, 8 cents (25)	.08	.3	5	1	6	53
Total animal food	1.28	4.1	16	93	6	916
VEGETABLE FOOD.						
Cereals: Corn meal, 15.5 pounds, 19 cents (33); flour, wheat, 33.5 pounds, 80 cents (37)	.99	3.2	67	14	531	2,516
Sugars, starches, etc.: Sugar, brown, 5 pounds, 25 cents (44)	.25	.8			70	280
Vegetables: Beets, pickled, 2.75 pounds, 14 cents (50); cabbage, 2 pounds, 4 cents (51); cucumber pickles, 2.5 pounds, 25 cents (61); potatoes, 33 per cent refuse, 24.25 pounds, 30 cents (62); sweet potatoes, 20 per cent refuse, 5 pounds, 5 cents (68); tomatoes, canned, 6.06 pounds, 30 cents (70); turnips, 4 pounds, 2 cents (71)	1.10	3.6	9	1	72	333
Fruits, etc.: Apples, 3.75 pounds, 8 cents (73); apples, canned, 1 pound, 10 cents (75); apple jelly, 2.63 pounds, 26 cents (76); peaches, canned, 2.5 pounds, 18 cents (88)	.62	2.0	1	1	47	201
Total vegetable food	2.96	9.6	77	16	720	3,330
Total food	4.24	13.7	93	109	726	4,246
Food wasted			3	1	19	97
Food actually eaten	4.24	13.7	90	108	707	4,149

The table above shows a rather more varied diet than is usual with these studies. The cost, 13.7 cents, is much above the average. The energy derived from the food consumed, 4,149 calories, is much larger than might be expected in a family where the activity was such as the data which could be collected imply was the case here. It is of course impossible to say what muscular work the man did, and it may possibly be that his energy requirements were unusually high. The protein consumed per man per day was slightly above the average for these studies. The nutritive value of the waste was larger than that in the majority of these studies.

DIETARY STUDY No. 633.

Dietary study No. 633 was made with a family of four persons. The father was employed in a coffin factory, while the boy was a teamster. The daily income of the family was $1.75 per day. They paid $3.50 per month for rent of a house, barn, and a half acre of land. They raised vegetables for their own use, and kept a cow. From the description of the house it would appear that a considerable attempt was made to make it homelike, as far as the means of the family would allow.

The study began October 26, 1903. The usual data concerning the members of the family are given below:

	Meals.
Man, age 44 years, weight 150 pounds	42
Woman, age 46 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	33
Man, age 24 years, weight 147 pounds	42
Girl, age 16 years, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	151

Equivalent to 1 man for 50 days.

Weights and cost of food and nutrients in dietary study No. 633.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shoulder clod, 5 pounds, 50 cents (4)	0.50	1.0	8	2	....	50
Pork: Lard, 2 pounds, 20 cents (12)	.20	.4	....	18	....	160
Butter, 7 pounds, $1.40 (21)	1.40	2.8	1	53	....	476
Milk, 10 pounds, 25 cents (24)	.25	.5	3	3	5	58
Buttermilk, 18 pounds, 11 cents (25)	.11	.2	5	1	5	49
Total animal food	2.46	4.9	17	77	10	793
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents (33); flour, wheat, 40 pounds, 96 cents (37)	1.20	2.4	50	11	402	1,906
Sugars, starches, etc.: Sugar, granulated, 4 pounds, 24 cents (45)	.24	.5	....	....	36	144
Vegetables: Potatoes, 29 per cent refuse, 6 pounds, 7 cents (62); sweet potatoes, 18 per cent refuse, 7 pounds, 7 cents (68)	.14	.3	2	....	21	92
Fruits, etc.: Apples, dried, 5 pounds, 25 cents (74)	.25	.5	1	1	30	133
Total vegetable food	1.83	3.7	53	12	489	2,275
Total food	4.29	8.6	70	89	499	3,068
Food wasted	....	....	....	....	2	8
Food actually eaten	4.29	8.6	70	89	497	3,060

The protein consumed by this family was somewhat below the average for these studies and far below the dietary standards. The energy corresponds closely with that of the American standard for man with light to moderate muscular work. Corn meal and wheat flour were the chief source of nourishment of this family.

The cost is slightly below the standard for these studies.

DIETARY STUDY No. 634.

The study was made with two persons, a man and wife. The man was a day laborer, and earned about $2 per week. His wife aided in the support by taking in washing, thereby earning $1.50 per week. They occupied an old three-room house, for which they paid $1.50 rent per month.

The study was made in the month of November, 1903. The age and weight of each of the subjects, and the number of meals taken by each, are given below:

	Meals.
Man, age 27 years, weight 140 pounds	42
Woman, age 24 years, weight 150 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	76

Equivalent to 1 man for 25 days.

Weights and cost of food and nutrients in dietary study No. 634.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 2 pounds, 20 cents (12); salt, fat, 3 pounds, 30 cents (14); sausage, 2.5 pounds, 25 cents (16)	*Dollars.* 0.75	*Cents.* 3.0	*Grams.* 9	*Grams.* 98	*Grams.*	*Calories.* 908
Butter, 3 pounds, 60 cents (21)	.60	2.4	1	45		405
Total animal food	1.35	5.4	10	143		1,313
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents (33); flour, wheat, 26 pounds, 62 cents (37)	.86	3.4	75	20	606	2,962
Sugars, starches, etc.: Sugar, granulated, 4 pounds, 24 cents (45)	.24	1.0			73	292
Vegetables: Cabbage, 2.5 pounds, 5 cents (51)	.05	.2	1		2	12
Total vegetable food	1.15	4.6	76	20	681	3,266
Total food	2.50	10.0	86	163	681	4,510
Food wasted			1	1	8	45
Food actually eaten	2.50	10.0	85	162	673	4,474

From the table above it will be seen that the food consumed in this study yielded 85 grams protein, 162 grams fat, and 673 grams carbohydrates. The fuel value of the ingested food was 4,474 calories. While the cost of the food per man per day and the amount of protein consumed very closely approximate the average for these studies, the energy value is much above it. This is probably very largely due to the amount of fat supplied by the animal food, pork and butter, which yielded 143 grams of fat, equivalent to 1,313 calories of energy per man per day. Undoubtedly the energy supplied by the food in this study was abundantly sufficient for the bodily activity of the subjects.

DIETARY STUDY No. 635.

Dietary study No. 635 was made with a family of two persons, a man and wife. The man was a pensioner, receiving $12 per month. He had no regular employment, but raised vegetables on a plat of about three-quarters of an acre. They owned the property on which they lived.

The study was made in November, 1903. The usual data concerning the members of the family are given below:

	Meals.
Man, age 56 years, weight 180 pounds	42
Woman, age 54, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	76
Equivalent to 1 man for 25 days.	

Weights and cost of food and nutrients in dietary study No. 635.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Beef: Shank, 10 pounds, 10 cents (2)	0.10	0.4	12	3	....	75
Pork: Lard, 2 pounds, 20 cents (12); salt, fat, 3 pounds, 30 cents (14); sausage, 3 pounds, 30 cents (16)	.80	3.2	11	102	....	952
Butter, 3 pounds, 60 cents (21)	.60	2.4	1	45	....	404
Total animal food	1.50	6.0	24	150	....	1,431
VEGETABLE FOOD.						
Cereals: Corn meal, 10 pounds, 12 cents (33); flour, wheat, 36 pounds, 86 cents (37)	.98	3.9	80	14	628	2,956
Sugars, starches, etc.: Sugar, granulated, 4 pounds, 24 cents (45)	.24	1.0	....	....	73	292
Vegetables: Sweet potatoes, 25 per cent refuse, 6 pounds, 6 cents (68); turnips, 4.5 pounds, 2 cents (71)	.08	.3	2	1	27	125
Fruits, etc: Blackberries, canned, 3.25 pounds, 23 cents (78)	.23	.9	....	1	33	141
Total vegetable food	1.53	6.1	82	16	761	3,514
Total food	3.03	12.1	106	166	761	4,945
Food wasted	....	....	1	1	8	45
Food actually eaten	3.03	12.1	105	165	753	4,900

From the table above it will be seen that for 12.1 cents per man per day this family obtained food which yielded 106 grams protein and 4,945 calories of energy, almost all of which was eaten. This study is above the average, both as regards nutrients, energy, and cost. Particularly noticeable is the amount of fat obtained from animal food, 150 grams, and it is one of the main sources of the high fuel value. There can be but little question that the diet was sufficient for the needs of the subjects, as neither of them can have done heavy work.

DIETARY STUDY No. 636.

This study was made with 8 persons, 3 adults and 5 boys, the latter ranging in age from 7 to 17 years. The older man draws a pension of $12 per month, a sum supplemented by the products of a small truck garden. The house in which they lived was much more elaborate than the majority of those observed.

The study began November 4, 1903. The ages and weights of the subjects, and the number of meals taken by each, are given below:

	Meals.
Man, age 56 years, weight 143 pounds	42
Man, age 24 years, weight 140 pounds	42
Boy, age 17 years, weight 120 pounds	42
Woman, age 21 years, weight 137 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 14 years, weight 104 pounds (42 meals × 0.8 meal of man), equivalent to	33
Boy, age 12 years, weight 90 pounds (42 meals × 0.7 meal of man), equivalent to	29
Boy, age 8 years, weight 63 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 1 year, weight 33 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	256

Equivalent to 1 man for 85 days.

Weights and cost of food and nutrients in dietary study No. 636.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shoulder clod, 3 pounds, 30 cents (4); steak, round, 2 pounds, 20 cents (6)	0.50	0.6	5	2	.....	38
Pork: Lard, 4.5 pounds, 45 cents (12); salt, fat, 13 pounds, $1.30 (14)	1.75	2.1	6	75	.....	691
Game, rabbit, 5 pounds, 25 cents (19)	.25	.3	4	2	.....	34
Butter, 3 pounds, 60 cents (21)	.60	.7	.....	13	.....	116
Total animal food	3.10	3.7	15	92	.....	879
VEGETABLE FOOD.						
Cereals: Corn meal, 30 pounds, 36 cents (33); flour, wheat, 76 pounds, $1.82 (37)	2.18	2.5	53	11	421	1,994
Sugars, starches, etc.: Sugar, brown, 4 pounds, 20 cents (44); sugar, granulated, 5 pounds, 30 cents (45)	.50	.6	.....	.....	47	188
Vegetables: Cabbage, 2.5 pounds, 5 cents (51); onions, 3.25 pounds, 6 cents (57); potatoes, 25 per cent refuse, 13 pounds, 16 cents (62); sweet potatoes, 29 per cent refuse, 35 pounds, 35 cents (68); turnips, 6.5 pounds, 3 cents (71)	.65	.8	4	1	50	225
Total vegetable food	3.33	3.9	57	12	518	2,407
Total food	6.43	7.6	72	104	518	3,286
Food wasted	.....	.....	.....	.....	1	4
Food actually eaten	6.43	7.6	72	104	517	3,282

The table above summarizes the study on the usual per man per day basis. It appears that the cost is below the average for these studies, and furthermore, that the protein is low. The energy is about midway between those suggested by the American standards for light and moderate muscular work. The children weighed more than the majority at their ages. Pork, corn meal, and flour were the principal foodstuffs used.

DIETARY STUDY No. 637.

This study was made with the family of a day laborer, employed at various sorts of job work, by which he earned about $2 per week. Their home was an old two-room house, unplastered and unpapered, for which they paid $1.50 rent per month.

The study commenced November 5, 1903. The usual data concerning the different members of the family are given below:

	Meals.
Man, age 24 years, weight 136 pounds	42
Woman, age 22 years, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 1 year, weight 18 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	89

Equivalent to 1 man for 30 days.

Weights and cost of food and nutrients in dietary study No. 637.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Salt, fat, 4 pounds, 40 cents (14); sausage, 2.5 pounds, 25 cents (16)	0.65	2.2	9	62		588
Butter, 3 pounds, 60 cents (21)	.60	2.0	1	38		342
Buttermilk, 14 pounds, 9 cents (25)	.09	.3	6	1	7	61
Total animal food	1.34	4.5	16	101	7	991
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents (33); flour, wheat, 24 pounds, 58 cents (37)	.82	2.7	59	16	482	2,306
Sugars, starches, etc.: Molasses, 13 pounds, 39 cents (43)	.39	1.3	5		136	564
Vegetables: Sweet potatoes, 34 per cent refuse, 16 pounds, 16 cents (68)	.16	.5	3	1	44	197
Fruits, etc.: Apples, dried, 4 pounds, 20 cents (74)	.20	.7	1	1	40	173
Total vegetable food	1.57	5.2	68	18	702	3,240
Total food	2.91	9.7	84	119	709	4,231
Food wasted			1		6	28
Food actually eaten	2.91	9.7	83	119	703	4,203

The results of this study as given in the preceding table show a high energy value. The cost is nearly a cent per man per day above the average. The protein, 83 grams, is just about an average for this series of studies.

DIETARY STUDY No. 638.

Dietary study No. 638 was made with the family of a teamster, earning on the average $20 per month. The rent paid for their home was $3.50 per month.

The study began November 11, 1903. The age and weight of each member of the family, and the number of meals taken by each, will be found below:

	Meals.
Man, age 24 years, weight 147 pounds	42
Woman, age 23 years, weight 126 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 4 years, weight 40 pounds (42 meals × 0.4 meal of man), equivalent to	17
Girl, age 1 year, weight 23 pounds (42 meals × 0.3 meal of man), equivalent to	12
Total number of meals equivalent to	105

Equivalent to 1 man for 35 days.

Weights and cost of food and nutrients in dietary study No. 638.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shank, 8 pounds, 8 cents (2)	0.08	0.2	7	2		46
Pork: Lard, 3 pounds, 30 cents (12); salt, fat, 6 pounds, 60 cents (14); sausage, 2 pounds, 20 cents (16)	1.10	3.1	9	108		997
Butter, 4 pounds, 80 cents (21)	.80	2.3	1	43		387
Total animal food	1.98	5.6	17	153		1,430
VEGETABLE FOOD.						
Cereals: Corn meal, 34 pounds, 41 cents (33); flour, wheat, 42.5 pounds, $1.02 (37)	1.43	4.1	89	24	719	3,445
Sugars, starches, etc.: Sugar, granulated, 2.5 pounds, 15 cents (45)	.15	.4			32	128
Vegetables: Beans, dried, 3 pounds, 15 cents (48); potatoes, 18 per cent refuse, 7 pounds, 7 cents (62); turnips, 4 pounds, 2 cents (71)	.24	.7	10	1	48	241
Fruits, etc.: Apples, 4 pounds, 8 cents (73)	.08	.2			6	24
Total vegetable food	1.90	5.4	99	25	805	3,838
Total food	3.88	11.0	116	178	805	5,268
Food wasted					2	8
Food actually eaten	3.88	11.0	116	178	803	5,260

As compared with the average of this series, study No. 638 will be observed to have high cost, protein, and energy. The energy particularly is about 1,600 calories above the average. There seems no question that this family was sufficiently nourished. The weight of both children is slightly above the average for their ages. As in several other studies here reported, corn meal, wheat flour, and salt pork furnished by far the larger part of the nutrients of the food consumed.

DIETARY STUDY No. 639.

The diet of the family of a factory operative is reported below. The father supported the family by his work in a coffin factory, where he earned 75 cents per day. Their home was a house of three rooms, which they rented for $2.50 per month. They were in decidedly poor circumstances. (Pl. II, fig. 2.)

The study was made in November of 1903. The usual data concerning the members of the family follow:

	Meals.
Man, age 27 years, weight 163 pounds	42
Woman, age 25 years, weight 146 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 2 years, weight 20 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	93

Equivalent to 1 man for 31 days.

Weights and cost of food and nutrients in dietary study No. 639.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 3 pounds, 30 cents (12); salt, fat, 4 pounds, 40 cents (14)	*Dollars.* 0.70	*Cents.* 2.2	*Grams.* 5	*Grams.* 87	*Grams.*	*Calories.* 794
Butter, 4 pounds, 80 cents (21)	.80	2.6	1	48	....	431
Total animal food	1.50	4.8	6	135	....	1,225
VEGETABLE FOOD.						
Cereals: Corn meal, 10 pounds, 12 cents (33); oats, rolled, 1.5 pounds, 8 cents (35); flour, wheat, 37 pounds, 89 cents (37)	1.09	3.5	69	13	532	2,520
Sugars, starches, etc.: Sugar, granulated, 3 pounds, 18 cents (45)	.18	.6	....	....	44	176
Vegetables: Beans, dried, 0.5 pound, 3 cents (48); cabbage, 2 pounds, 4 cents (51); cowpeas, Clay, dried, 2 pounds, 6 cents (55); onions, 2.44 pounds, 4 cents (57); potatoes, 25 per cent refuse, 14 pounds, 18 cents (62); sweet potatoes, 33 per cent refuse, 13 pounds, 13 cents (68); turnips, 2 pounds, 1 cent (71)	.49	1.6	15	2	92	446
Total vegetable food	1.76	5.7	84	15	668	3,142
Total food	3.26	10.5	90	150	668	4,367
Food wasted	....	....	3	3	17	107
Food actually eaten	3.26	10.5	87	147	651	4,260

The table above shows that the family consumed 87 grams protein and 4,260 calories of energy per man per day, which cost 10.5 cents per day. These figures are all above the average for these studies, but the protein falls below the American standards. The waste in this study was rather above the ordinary.

DIETARY STUDY No. 640.

Dietary study No. 640 was made with the family of a carpenter not having regular employment. He earned on the average about $4 per week. His rent cost him $3 per month. From this statement it will appear that this family were in very humble circumstances.

The study began November 18, 1903. The age and weight of each member of the family, and the number of meals taken, are given herewith:

	Meals.
Man, age 26 years, weight 172 pounds	42
Man, age 70 years, weight 142 pounds	42
Woman, age 24 years, weight 157 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 2 years, weight 34 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	135

Equivalent to 1 man for 45 days.

Weights and cost of food and nutrients in dietary study No. 640.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shank, 8 pounds, 8 cents (2); steak, round, 2 pounds, 20 cents (6)	0.28	0.6	10	3	....	67
Pork: Chuck ribs, 10 pounds, 50 cents (8); head, 18 pounds, 45 cents (9); liver, 9 pounds, 6 cents, (11); lard, 3 pounds, 30 cents (12); salt, fat, 2.5 pounds, 25 cents (14); sausage, 2 pounds, 20 cents (16)	1.76	3.9	45	113	1	1,189
Total animal food	2.04	4.5	55	116	1	1,256
VEGETABLE FOOD.						
Cereals: Corn meal, 13 pounds, 16 cents (33); flour, wheat, 47 pounds, $1.13 (37)	1.29	2.9	57	10	455	2,137
Sugars, starches, etc.: Molasses, 12 pounds, 36 cents (43); sugar, granulated, 4 pounds, 24 cents (45)	.60	1.3	3	....	124	508
Vegetables: Beans, dried, 2 pounds, 10 cents (48); potatoes, 33 per cent refuse, 15 pounds, 19 cents, (62); sweet potatoes, 37 per cent refuse, 19 pounds, 19 cents (68)	.48	1.1	9	1	64	301
Total vegetable food	2.37	5.3	69	11	643	2,946
Total food	4.41	9.8	124	127	644	4,202
Food wasted	....	....	....	....	1	4
Food actually eaten	4.41	9.8	124	127	643	4,198

The diet of this family yielded per man per day 124 grams protein, 127 grams fat, and 643 grams carbohydrates, having a fuel value of 4,198 calories. The cost per man per day was 9.8 cents. The amount of protein is that suggested by the American standard for a man at moderate muscular work, the energy being greatly in excess of the same standard. The cost is slightly above the average for these

studies. It seems safe to assert that this family had sufficient protein and energy for their bodily needs. From an economical standard this study makes a very good showing, the nutrients and energy supply being, in proportion to the expenditure, much less than was the case in very many of these studies.

DIETARY STUDY No. 641.

This study was made with the family of a teamster. They occupied a four-room house, for which they paid $2.50 rent per month. The income of the family was 50 cents per day.

The study began November 18, 1903. The usual data concerning the members of the family are given below:

	Meals.
Man, age 29 years, weight 172 pounds	42
Woman, age 27 years, weight 146 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 10 years, weight 76 pounds (42 meals × 0. 6 meal of man), equivalent to	25
Girl, age 7 years, weight 68 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 5 years, weight 59 pounds (42 meals × 0.4 meal of man), equivalent to	17
Boy, age 1 year, weight 20 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	152

Equivalent to 1 man for 51 days.

Weights and cost of food and nutrients in dietary study No. 641.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Pork: Liver, 8 pounds, 5 cents (11); lard, 3.5 pounds, 35 cents (12); salt, fat, 10 pounds, $1 (14); sausage, 1 pound, 10 cents (25)	1.50	2.9	23	104	1	1,021
Buttermilk, 16 pounds, 10 cents (16)	.10	.2	4	1	5	45
Total animal food	1.60	3.1	27	105	6	1,066
VEGETABLE FOOD.						
Cereals: Corn meal, 30 pounds, 36 cents (33); flour, wheat, 36 pounds, 86 cents (37)	1.22	2.4	52	14	425	2,033
Sugars, starches, etc.: Sugar, granulated, 6 pounds, 36 cents (45)	.36	.7			53	212
Vegetables: Cabbage, 7.5 pounds, 15 cents (51); turnips, 5 pounds, 3 cents (71)	.18	.4	2		6	32
Fruits, etc.: Apples, dried, 3 pounds, 15 cents (74); blackberry jelly, 1.75 pounds, 18 cents (80); peaches, canned, 2.5 pounds, 18 cents (88)	.51	1.0	1	1	32	141
Total vegetable food	2.27	4.5	55	15	516	2,418
Total food	3.87	7.6	82	120	522	3,484
Food wasted					2	8
Food actually eaten	3.87	7.6	82	120	520	3,476

The diet supplied very nearly the amounts of protein and energy which are the average for the whole series of studies. The cost was 1.2 cents per man per day less than this average. Pork, corn meal, and flour were the chief articles of food. The children are up to or above normal weight.

DIETARY STUDY No. 642.

This family occupied two rooms, which they rented for $1.50 per month. The father was an employee of a coffin factory and received $1.25 per day.

The study began November 18, 1903. Below are given the ages and weights of the family, and the number of meals taken by each member:

	Meals.
Man, age 44 years, weight 152 pounds	42
Woman, age 41 years, weight 137 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 11 years, weight 56 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 10 years, weight 47 pounds (42 meals × 0.6 meal of man), equivalent to	25
Girl, age 7 years, weight 48 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 6 years, weight 50 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 15 months, weight 24 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	181

Equivalent to 1 man for 60 days.

Weights and cost of food and nutrients in dietary study No. 642.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shoulder clod, 3 pounds, 30 cents (4)	0.30	0.5	4	1	....	25
Pork: Lard, 4 pounds, 40 cents (12); salt, fat, 10 pounds, $1 (14)	1.40	2.3	6	85	....	781
Butter, 4 pounds, 80 cents (21)	.80	1.3	1	25	....	226
Buttermilk, 18 pounds, 11 cents (25)	.11	.2	4	1	5	45
Total animal food	2.61	4.3	15	112	5	1,077
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents (33); flour, wheat, 54 pounds, $1.30 (37)	1.54	2.6	53	10	417	1,969
Sugars, starches, etc.: Molasses, 19 pounds, 48 cents (43); sugar, granulated, 6 pounds, 36 cents (45)	.84	1.4	3	....	145	592
Vegetables: Beans, dried, 5 pounds, 25 cents (48); onions, 2 pounds, 4 cents (57); potatoes, 18 per cent refuse, 30 pounds, 38 cents (62); sweet potatoes, 24 per cent refuse, 37 pounds, 37 cents (68); turnips, 20 pounds, 10 cents (71)	1.14	1.9	17	3	126	599
Total vegetable food	3.52	5.9	73	13	688	3,160
Total food	6.13	10.2	88	125	693	4,237
Food wasted	....	....	1	1	6	37
Food actually eaten	6.13	10.2	87	124	687	4,200

The table (p. 75) shows a diet in which the protein was obtained very largely from vegetable food. The total protein consumption is somewhat more than the average for these studies, but is certainly much below the dietary standard, even that for light muscular work. The energy is high, 600 calories more than the average for these studies and 1,000 more than the standard for a man with light to moderate muscular work. The waste, as usual with these studies, was small in amount and in nutritive value. Corn meal and flour were much-used articles of food. The cost per man per day is about 1 cent higher than the average for these studies.

DIETARY STUDY No. 643.

The study was made with two women, neither of whom had any occupation other than the customary housework. They owned the house, in half of which they lived, the other half being rented to the family described in the preceding study. The elder woman was a pensioner, and the $12 per month which she received supported the two.

This study was made in November, 1903. The usual data concerning the subjects follow:

	Meals.
Woman, age 80 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 20 years, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	33
Total number of meals equivalent to	67

Equivalent to 1 man for 22 days.

Weights and cost of food and nutrients in dietary study No. 643.

Food consumed during the entire study (14 days). Kinds and amounts.	Cost.	Cost, nutrients, and fuel value of food per man per day. Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Sausage, 2 pounds, 20 cents (16)	0.20	0.9	5	19		189
Butter, 2 pounds, 40 cents (21)	.40	1.8	1	34		307
Buttermilk, 8 pounds, 5 cents (25)	.05	.2	5	1	6	53
Total animal food	.65	2.9	11	54	6	549
VEGETABLE FOOD.						
Cereals: Corn meal, 10 pounds, 12 cents (33); flour, wheat, 24 pounds, 58 cents, (37); rice, 5 pounds, 30 cents (36)	1.00	4.6	73	14	602	2,824
Sugars, starches, etc.: Sugar, granulated, 8.5 pounds, 51 cents (45)	.51	2.3			175	700
Total vegetable food	1.51	6.9	73	14	777	3,524
Total food	2.16	9.8	84	68	783	4,073
Food wasted			1	1	7	41
Food actually eaten	2.16	9.8	83	67	776	4,032

Although the data of the preceding table are given in terms of per man per day, it is very easy to compute the results to terms of per woman per day. If this be done, it will be found that each of the subjects of the study received 66 grams protein, 54 grams fat, and 620 grams carbohydrates, yielding 3,225 calories of energy. There seems to be no doubt that this ration furnished energy enough for their needs, but the amount of protein, 66 grams per woman per day, is smaller than the average. It must be remembered in considering this matter, however, that the activity of these women was probably slight. The cost was high for the region.

DIETARY STUDY No. 644.

This study was made with the family of a factory operative receiving 75 cents per day for his work. The family occupied a three-room house, for which they paid $2.50 per month rent. There was no means of ascertaining the activity of the father, but that of the other members of the family was probably about the same as the average.

The study began November 27, 1903. The ages and weights of the different members of the family, and the number of meals taken by each, are given below:

	Meals.
Man, age 42 years, weight 148 pounds	42
Woman, age 46 years, weight 139 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 22 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 16 years, weight 90 pounds (42 meals × 0.8 meal of man), equivalent to	33
Girl, age 13 years, weight 76 pounds (42 meals × 0.7 meal of man), equivalent to	29
Total number of meals equivalent to	172

Equivalent to 1 man for 57 days.

Weights and cost of food and nutrients in dietary study No. 644.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.					
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Shank, 10 pounds, 10 cents (2)	0.10	0.2	5	2	....	38
Pork: Lard, 3.31 pounds, 33 cents (12); salt, fat, 14 pounds, $1.40 (14)	1.73	3.0	9	108	....	997
Buttermilk, 22 pounds, 14 cents (25)	.14	.2	5	1	6	53
Total animal food	1.97	3.4	19	111	6	1,088

Weights and cost of food and nutrients in dietary study No. 644—Continued.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
VEGETABLE FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Cereals: Corn meal, 27 pounds, 32 cents (33); flour, wheat, 46 pounds, $1.10 (37)	1.42	2.5	53	13	427	2,036
Vegetables: Cabbage, 16 pounds, 32 cents (51)	.32	.6	2		7	36
Total vegetable food	1.74	3.1	55	13	434	2,072
Total food	3.71	6.5	74	124	440	3,160
Food wasted			1	1	7	41
Food actually eaten	3.71	6.5	73	123	433	3,119

Only seven articles of food were used during the two weeks of this study. From this it will be seen that the diet was very lacking in variety. Both the protein and energy supplied are somewhat below the average for these studies. The energy, however, is much more nearly that of the usual standards than is the protein. The cost, 6.5 cents, is very low, 2.3 cents less than the average for these studies. The children were noticeably below the average for their ages in weight.

DIETARY STUDY No. 645.

This study was made with the family of a factory operative. Their weekly income was about $6.30. Their home was a four-room house, for which they paid $2.50 rent.

The study began December 2, 1903. The usual data concerning the members of the family are given below:

	Meals.
Man, age 26 years, weight 170 pounds	42
Man, age 47 years, weight 138 pounds	42
Woman, age 22 years, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 46 years, weight 153 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	152

Equivalent to 1 man for 51 days.

Weights and cost of food and nutrients in dietary study No. 645.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Beef: Shoulder clod, 2 pounds, 20 cents (4); steak, round, 4.5 pounds, 45 cents (6)	0.65	1.3	11	3		71
Pork: Lard, 3.25 pounds, 33 cents (12); salt, fat, 0.94 pound, 9 cents (14)	.42	.8	1	35		315
Fish: Perch, 1 pound, 13 cents (17)	.13	.3	1			4
Game: Rabbit, 6 pounds, 30 cents (19)	.30	.6	7	5		73
Butter, 2.31 pounds, 46 cents (21)	.46	.9		17		151
Total animal food	1.96	3.9	20	60		614
VEGETABLE FOOD.						
Cereals: Corn meal, 15 pounds, 18 cents (33); flour, wheat, 43.31 pounds, $1.04 (37)	1.22	2.4	49	9	388	1,828
Sugars, starches, etc.: Molasses, 4.5 pounds, 14 cents (43); sugar, granulated, 3 pounds, 18 cents (45)	.32	.6	1		54	220
Vegetables: Beans, dried, 2 pounds, 10 cents (48); potatoes, 18 per cent refuse, 7 pounds, 9 cents (62); sweet potatoes, 35 per cent refuse, 18 pounds, 18 cents (68)	.37	.7	7	1	49	233
Fruits, etc.: Apples, dried, 2.5 pounds, 12 cents (74)	.12	.2		1	15	69
Total vegetable food	2.03	3.9	57	11	506	2,350
Total food	3.99	7.8	77	71	506	2,964
Food wasted			2	2	13	78
Food actually eaten	3.99	7.8	75	69	493	2,886

This study is chiefly noticeable because of the small amount of energy in the food eaten and for the variety of animal food consumed. Both protein and energy are lower than the average for these studies, while the cost closely approaches the average for the families studied.

DIETARY STUDY No. 646.

Dietary study No. 646 was made with a family of five, a widow and her four children. Two boys and the elder girl were wage-earners, their total earnings amounting to somewhat less than $1 per day. They occupied a three-room house, for which they paid $2 per month rent.

The study began December 2, 1903. The ages and weights of the several members of the family, and the number of meals taken by each, are given below:

	Meals.
Woman, age 46 years, weight 149 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 19 years, weight 138 pounds	42
Girl, age 20 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34

	Meals.
Girl, age 15 years, weight 101 pounds (42 meals × 0.8 meal of man), equivalent to	33
Boy, age 14 years, weight 90 pounds (42 meals × 0.8 meal of man), equivalent to	33
Total number of meals equivalent to	176

Equivalent to 1 man for 59 days.

Weights and cost of food and nutrients in dietary study No. 646.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 9 pounds, 90 cents (12), salt, fat, 7 pounds, 70 cents (14)	*Dollars.* 1.60	*Cents.* 2.7	*Grams.* 4	*Grams.* 108	*Grams.*	*Calories.* 977
Butter, 4.25 pounds, 85 cents (21)	.85	1.4	1	27		244
Buttermilk, 56 pounds, 35 cents (25)	.35	.6	13	3	15	139
Total animal food	2.80	4.7	18	138	15	1,360
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents, (33); flour, wheat, 38 pounds, 91 cents (37)	1.15	2.0	41	9	329	1,560
Sugars, starches, etc.: Sugar, granulated, 8 pounds, 48 cents (45)	.48	.8			61	244
Total vegetable food	1.63	2.8	41	9	390	1,804
Total food	4.43	7.5	59	147	405	3,164
Food wasted					3	12
Food actually eaten	4.43	7.5	59	147	402	3,152

This study shows a diet very lacking in variety. Only seven articles of food were used during the time of the study, corn meal, flour, and pork being the principal ones. The amount of lard (9 pounds) used seems very large, and would indicate that the food of this family must have largely been cooked by frying. The amount of protein per man per day, 59 grams, is very small.

DIETARY STUDY No. 647.

The subjects of this dietary study were the family of a railroad section hand earning $1 per day. They occupied a four-room house and paid $2.50 per month rent.

The study was made in December, 1903. The usual data concerning the different members of the family are given below:

	Meals.
Man, 38 years, weight 150 pounds	42
Woman, age 36 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	33
Boy, age 15 years, weight 102 pounds (42 meals × 0.9 meal of man), equivalent to	38
Girl, age 5 years, weight 30 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	130

Equivalent to 1 man for 43 days.

FIG. 1.—HOME OF BRICK MASON. DIETARY STUDY NO. 648.

FIG. 2.—HOME OF SAWMILL OPERATIVE. DIETARY STUDY NO. 651.

Weights and cost of food and nutrients in dietary study No. 647.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Chuck ribs, 2.5 pounds, 13 cents (8); lard, 4.25 pounds, 43 cents (12); salt, fat, 13 pounds, $1.30 (14); sausage, 3.5 pounds, 35 cents (16)	*Dollars.* 2.21	*Cents.* 5.1	*Grams.* 19	*Grams.* 169	*Grams.*	*Calories.* 1,580
Total animal food	2.21	5.1	19	169	....	1,580
VEGETABLE FOOD.						
Cereals: Corn meal, 16 pounds, 19 cents (33); flour, wheat, 30 pounds, 72 cents (37)	.91	2.1	45	10	357	1,697
Sugars, starches, etc.: Sugar, brown, 2 pounds, 10 cents (44)	.10	.2	....	....	20	80
Vegetables: Beans, dried, 2 pounds, 10 cents (48); cabbage, 10 pounds, 20 cents (51); onions, 2 pounds, 4 cents (57)	.34	.8	6	1	21	117
Total vegetable food	1.35	3.1	51	11	398	1,894
Total food	3.56	8.2	70	180	398	3,474
Food wasted	....	....	1	1	8	45
Food actually eaten	3.56	8.2	69	179	390	3,429

From the table above it appears that in this study there were consumed per man per day 69 grams protein, 179 grams fat, and 390 grams carbohydrates, with a fuel value of 3,429 calories. This diet seems typical of this series of studies, where the energy is large as compared with the protein. The cost was 0.6 cent less than the average for these studies. The children weighed less than the normal weights for their ages.

DIETARY STUDY No. 648.

Dietary study No. 648 was made with the family of a brick mason. He earned $2.50 per day, while one son also added $1 per day to the income of the family. From this it will be seen that this family had the maximum income for this series of studies. They owned and occupied a four-room house (Pl. III, fig. 1). A very good garden furnished them with vegetables of the ordinary kinds. From data accompanying this study it is evident that their house was better furnished and equipped than was the case with the majority of these families.

The study began December 5, 1903. The ages and weights of the members of the family, and the number of meals taken by each, are given below:

	Meals.
Man, age 46 years, weight 162 pounds	42
Woman, age 48 years, weight 187 pounds (42 meals × 0.8 meal of man), equivalent to	34
Man, age 21 years, weight 160 pounds	42

	Meals.
Girl, age 15 years, weight 120 pounds (42 meals × 0.8 meal of man), equivalent to	33
Boy, age 11 years, weight 90 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 9 years, weight 77 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 16 months, weight 54 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	210

Equivalent to 1 man for 70 days.

Weights and cost of food and nutrients in dietary study No. 648.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Steak, round, 4 pounds, 40 cents (6)	0.40	0.6	5	2		38
Pork: Lard, 5 pounds, 30 cents (12); salt, fat, 18 pounds, $1.80 (14)	2.10	3.0	9	118		1,086
Butter, 3 pounds, 60 cents (21)	.60	.8		16		142
Total animal food	3.10	4.4	14	136		1,266
VEGETABLE FOOD.						
Cereals: Corn meal, 48 pounds, 58 cents (33); flour, wheat, 74 pounds, $1.78 (37)	2.36	3.4	72	18	578	2,760
Sugars, starches, etc.: Sugar, granulated, 11 pounds, 66 cents (45)	.66	.9			71	284
Vegetables: Cabbage, 4 pounds, 8 cents (51); onions, 3 pounds, 5 cents (57)	.13	.2	1		3	16
Fruits, etc.: Apples, 6 pounds, 12 cents (73)	.12	.2			4	16
Total vegetable food	3.27	4.7	73	18	656	3,076
Total food	6.37	9.1	87	154	656	4,342
Food wasted			1	1	8	45
Food actually eaten	6.37	9.1	86	153	648	4,297

Although this family had the largest income of the 45 here studied, the cost of their food was almost the average for this series of studies. The diet was low in protein and high in energy. It is to be noticed in this connection that the members of the family were rather above ordinary weight. It may be that there was a tendency to store fat in their bodies, which may have some connection with the high energy consumption. The protein is only slightly above the average for these studies.

DIETARY STUDIES IN REMOTE MOUNTAIN DISTRICTS, Nos. 649–667.

In this section are included nineteen dietary studies (Nos. 649–667) of families living in Tennessee mountain districts, remote from towns.

DIETARY STUDY No. 649.

This study was made in the family of a farmer who had lived on his present place since before the civil war. He served in the army during the war, and now draws a monthly pension of $12. He owns the farm, valued at $450, and a considerable amount of live stock and farming implements. He had about 75 acres of land under cultivation, on which he raised corn, wheat, vegetables, and clover, and also owned 60 acres of timber and some rough mountain land.

The house was an unplastered, rough, wooden building, with 3 small rooms and 1 window to each room. The furniture, which was fairly good for this region, consisted of 3 large beds, 10 chairs, 3 tables, a cook stove, a safe for dishes, another for food, and a clock.

Like most mountaineers, the family dressed rather poorly, the man's clothing costing about $12 a year, and being paid for in produce. The circumstances of this family appear to have been rather better than those of most of their neighbors.

This study began August 10, 1904, and continued fourteen days, with 42 meals. The weights and ages of the family are as follows:

	Meals.
Man, age 66 years, weight 168 pounds	42
Woman, age 61 years, weight 153 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	76
Equivalent to 1 man for 25 days.	

Weights and cost of food and nutrients in dietary study No. 649.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 3.06 pounds, 31 cents (12); salt, 5 pounds, 50 cents (14)	0.81	3.2	7	122	......	1,114
Dairy products: Butter, 3.56 pounds, 71 cents (21); buttermilk, 36 pounds, 23 cents (25); milk, skimmed, 20 pounds, 15 cents (31)	1.09	4.4	33	58	41	812
Total animal food	1.90	7.6	40	180	41	1,926
VEGETABLE FOOD.						
Cereals: Corn meal, 13.50 pounds, 16 cents (33); flour, 27 pounds, 65 cents (37)	.81	3.2	68	15	543	2,578
Sugars, etc.: Sugar, brown, 2 pounds, 10 cents (44)	.10	.4	......	......	34	136
Vegetables: Potatoes, white, 38 per cent refuse, 9 pounds, 11 cents (62); potatoes, sweet, 33 per cent refuse, 16.56 pounds, 17 cents (68)	.28	1.1	6	2	74	338
Total vegetable food	1.19	4.7	74	17	651	3,052
Total food	3.09	12.3	114	197	692	4,978
Food wasted	......	......	......	......	2	8
Food actually eaten	3.09	12.3	114	197	690	4,970

The amount of protein which this family obtained from the diet here reported is 114 grams, much higher than in the majority of these studies, and corresponds closely to the standard for light muscular work, 112 grams. This is undoubtedly due to the use of skim milk and buttermilk, which was made possible by the fact that the family owned two cows. The energy supplied was 4,978 calories, considerably in excess of the standard even for moderate muscular work; this large amount is partly due to larger quantities of all the food materials than are consumed on the average, but partly also to the use of butter, which made the amount of fat eaten 50 per cent greater than the average. The cost of the diet, 12.3 cents, is strikingly high. It is half again as high as the average, by far the highest in this series of studies and sixth among the entire 64 studies. This, too, seems due to the use of dairy products. It is interesting to note that if the latter were withdrawn from the diet, the cost and protein would about equal the amounts in the average of these studies.

DIETARY STUDY No. 650.

The man and his family here described lived with his father on the farm described in the preceding study. Their house was a new box house of two unplastered rooms. The entire family slept in one room. The general character of the furniture and of the clothing was very like that described in study No. 649.

This study began August 10, 1904, and continued fourteen days with 42 meals. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 28 years, weight 180 pounds	42
Woman, age 25 years, weight 176 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 14 years, weight 104 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 12 years, weight 90 pounds (42 meals × 0.6 meal of man), equivalent to	25
Girl, age 8 years, weight 60 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 4 years, weight 48 pounds (42 meals × 0.4 meal of man), equivalent to	17
Boy, age 4 months, weight 30 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	186

Equivalent to 1 man for 62 days.

Weights and cost of food and nutrients in dietary study No. 650.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 7 pounds, 70 cents (12); salt, 7 pounds, 70 cents (14)	*Dollars.* 1.40	*Cents.* 2.3	*Grams.* 4	*Grams.* 89	*Grams.*	*Calories.* 808
Dairy products: Butter, 6 pounds, $1.20 (21); buttermilk, 57 pounds, 37 cents (25); milk, skimmed, 40 pounds, 30 cents (31)	1.87	3.0	23	40	29	564
Total animal food	3.27	5.3	27	129	29	1,372
VEGETABLE FOOD.						
Cereals: Corn meal, 34.56 pounds, 42 cents (33); flour, 47.5 pounds, $1.14 (37)	1.56	2.5	54	14	437	2,089
Vegetables: Cabbage, 9 pounds, 18 cents (51); onions, 3 pounds, 5 cents (57); potatoes, white, 17 per cent refuse, 26 pounds, 33 cents (62); potatoes, sweet, 22 per cent refuse, 47.5 pounds, 48 cents (68)	1.04	1.7	10	2	109	494
Total vegetable food	2.60	4.2	64	16	546	2,583
Total food	5.87	9.5	91	145	575	3,955
Food wasted	....	....	....	......	1	4
Food actually eaten	5.87	9.5	91	145	574	3,951

The general character of this diet is similar to that described in the preceding study, save that the quantities of all the different materials run slightly smaller, with correspondingly lower total figures. The protein furnished amounted to 91 grams, slightly more than the average for these studies, but noticeably less than the standard. The energy, 3,955 calories, is especially high, owing probably to the use of butter.

The cost of this diet is 9.5 cents, slightly greater than the average; the difference, as in the preceding study, is probably due to the use of dairy products, especially butter.

DIETARY STUDY No. 651.

The man in whose family this study was made had steady work in a sawmill, for which he received $1.50 a day. They rented one room of an old, two-room log house for 50 cents a month (Pl. III, fig. 2). The furniture was scarce and rough, and the walls were neither plastered nor papered. The cooking was done in the fireplace. This family lived very economically and saved considerable money in proportion to their income.

The study began August 10, 1904, and continued fourteen days, with 42 meals. The members of the family, the weights and ages, and the number of meals taken, were as follows.

	Meals.
Man, age 54 years, weight 156 pounds	42
Woman, age 43 years, weight 139 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 4 years, weight 50 pounds (42 meals × 0.4 meal of man), equivalent to	17
Girl, age 7 months, weight 26 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	106

Equivalent to 1 man for 35 days.

Weights and cost of food and nutrients in dietary study No. 651.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 9 pounds, 90 cents (12); salt, 7 pounds, 70 cents (14)	Dollars. 1.60	Cents. 4.6	Grams. 7	Grams. 183	Grams.	Calories. 1,657
Total animal food	1.60	4.6	7	183	....	1,657
VEGETABLE FOOD.						
Cereals: Corn meal, 19 pounds, 23 cents (33); flour, 36.75 pounds, 88 cents (37)	1.11	3.2	67	16	533	2,542
Vegetables: Cabbage, 7.13 pounds, 14 cents (51); potatoes, white, 37 per cent refuse, 17.56 pounds, 22 cents (62)	.36	1.0	4	....	31	140
Total vegetable food	1.47	4.2	71	16	564	2,682
Total food	3.07	8.8	78	199	564	4,339
Food wasted	....	....	....	....	1	4
Food actually eaten	3.07	8.8	78	199	563	4,335

The protein supplied by this diet is 78 grams, just about the average amount for the series. The energy, 4,335 calories, is considerably above the average and even above the standard for moderate muscular work. This excess of energy seems mainly due to the large quantities of lard used, which rather indicate that most of the food was fried. Just about the average price was paid for the daily food supply. This diet was evidently economical and abundant as far as energy is concerned, but it was somewhat lacking in protein. The weights given for both children are half again as heavy as those of the majority at their ages.

DIETARY STUDY No. 652.

The widow whose dietary is here studied owned the house described in dietary No. 651, and lived alone in the unrented room, in which she cooked, ate, and slept. The furniture was poor, but seemed sufficient for her needs. She cooked in the fireplace. The farm contained 12 acres of rough, poor land, located in a mountain ravine, and was valued at $100, but none of it was cultivated. The woman owned a cow valued at $18. She drew a pension of $12 per month.

This study began August 10, 1904, and continued fourteen days, with 42 meals. The age and weight of the subject, and the number of meals taken, were as follows:

	Meals.
Woman, age 74 years, weight 161 pounds (42 meals $\times$ 0.8 meal of man), equivalent to	34
Equivalent to 1 man for 11 days.	

Weights and cost of food and nutrients in dietary study No. 652.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Dairy products: Butter, 1 pound, 20 cents (21); buttermilk, 16.56 pounds, 10 cents (25); milk, skimmed, 9 pounds, 7 cents (31)	*Dollars.* 0.37	*Cents.* 3.4	*Grams.* 34	*Grams.* 39	*Grams.* 42	*Calories.* 651
Total animal food	.37	3.4	34	39	42	651
VEGETABLE FOOD.						
Cereals: Corn meal, 14 pounds, 17 cents (33)	.17	1.5	43	25	381	1,919
Vegetables: Potatoes, white, 44 per cent refuse, 9 pounds, 11 cents (62)	.11	1.0	5		38	172
Total vegetable food	.28	2.5	48	25	419	2,091
Total food	.65	5.9	82	64	461	2,742
Food wasted					3	12
Food actually eaten	.65	5.9	82	64	458	2,730

This dietary is remarkable for its simplicity; it consists entirely of corn meal, potatoes, buttermilk, skim milk, and butter, with no animal food but the dairy products. It yielded the equivalent of 82 grams of protein and 2,730 calories of energy per man per day. The protein is very like the average for these studies, but the energy is much lower, chiefly because the small amount of butter used did not furnish so much as the pork and lard ordinarily eaten. The cost, 5.9 cents, is very low. That the woman was sufficiently nourished is not much in question. Her diet was in all respects below the standard for light exercise, but she was old, and probably her requirements were less than the standard calls for. From the description given, there seems no reason to suppose she could not buy food enough to satisfy her wants.

DIETARY STUDY No. 653.

This study was made in the family of a farmer who owned his farm, valued at $300. It included 90 acres of good land, 8 of which were cultivated, 2 of them as a garden. There was a good, dry barn, a good corncrib, and a good smokehouse on the place.

The old log house in which the family lived had two rooms, and was fairly well furnished for the neighborhood.

This study began August 10, 1904, and continued fourteen days. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 37 years, weight 171 pounds	42
Woman, age 30 years, weight 167 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 16 years, weight 142 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 12 years, weight 109 pounds (42 meals × 0.7 meal of man), equivalent to	29
Boy, age 7 years, weight 69 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 7 months, weight 30 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	173

Equivalent to 1 man for 57 days.

Weights and cost of food and nutrients in dietary study No. 653.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 3 pounds, 30 cents (12); salt, 8 pounds, 80 cents (14)	*Dollars.* 1.10	*Cents.* 1.9	*Grams.* 5	*Grams.* 71	*Grams.*	*Calories.* 652
Total animal food	1.10	1.9	5	71		652
VEGETABLE FOOD.						
Cereals: Corn meal, 30 pounds, 36 cents (33); flour, wheat, 50.5 pounds, $1.21 (37)	1.57	2.8	59	14	470	2,243
Sugars, etc.: Sugar, granulated, 2 pounds, 12 cents (45)	.12	.2			16	64
Total vegetable food	1.69	3.0	59	14	486	2,307
Food actually eaten	2.79	4.9	64	85	486	2,959

This dietary is almost as simple as the preceding one, as it consists only of corn meal, wheat flour, and salt pork, with lard for frying, and a little sugar. The amount of protein supplied is very small, only 64 grams, while the energy, 2,959 calories, is hardly more than the standard for light muscular work. The head of the family probably did as much work as that indicated in the standard for moderate muscular work (3,400 calories). The children are all extremely heavy for their ages. The financial condition of the family does not appear to have been such that they could not afford more food if they needed it, especially as the amount expended (4.9 cents per man per day) is much lower than the average among such families. It seems probable that this family found their diet fairly satisfactory in spite of its poverty and monotony.

DIETARY STUDY No. 654.

This study was made in the family of a sawmill operative who owned the farm on which they lived. The father and one son worked in the sawmill, each earning $1 a day. The farm contained 13 acres of very poor land, valued at $150. They had a garden in which they raised various vegetables. The family lived in an old log house with two rooms, in one of which all the family slept.

This study began August 10, 1904, and continued fourteen days. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 57 years, weight 180 pounds	42
Woman, age 18 years, weight 172 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 16 years, weight 140 pounds (42 meals × 0.9 meal of man), equivalent to	38
Girl, age 11 years, weight 111 pounds (42 meals × 0.6 meal of man), equivalent to	25
Girl, age 8 years, weight 88 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 7 years, weight 64 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 4 months, weight 16 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	194

Equivalent to 1 man for 64 days.

Weights and cost of food and nutrients in dietary study No. 654.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 4.56 pounds, 46 cents (12); salt, 6 pounds, 60 cents (14)	*Dollars.* 1.06	*Cents.* 1.7	*Grams.* 3	*Grams.* 63	*Grams.*	*Calories.* 573
Total animal food	1.06	1.7	3	63		573
VEGETABLE FOOD.						
Cereals: Corn meal, 38.5 pounds, 46 cents (33); flour, 47 pounds, $1.13 (37)	1.59	2.5	54	15	439	2,106
Sugars, etc.: Sugar, brown, 5.06 pounds, 25 cents (44)	.25	.4			34	136
Vegetables: Corn, green, 9 pounds, 45 cents (52)	.45	.7	2	1	13	69
Total vegetable food	2.29	3.6	56	16	486	2,311
Total food	3.35	5.3	59	79	486	2,884
Food wasted					1	4
Food actually eaten	3.35	5.3	59	79	485	2,880

The amount of protein supplied in this dietary is a trifle smaller even than that in the preceding study, and is hardly more than one-half the amount called for by the standard for light muscular work. The energy is slightly less than the amount required by that standard. The men of the family probably did at least moderate muscular work, for which the standard requirements are 125 grams of protein and 3,400 calories of energy. The cost of the food, 5.3 cents per man per day, is very slightly higher than in study No. 653, the difference being mainly due to the green corn used in the present case. This corn adds a pleasant variety to the very monotonous fare, but does not furnish protein or energy so economically as the other foods consumed. It seems a little strange that this family should not have used more of the green vegetables which must have been ripening in their garden at the time the study was made. Their financial condition was fully as good as the average in these studies, and if, as seems almost inevitable, they were not sufficiently nourished, it must have happened without discomfort or they would have increased their diet. The adults and the children appear unusually heavy.

DIETARY STUDY No. 655.

This study was made in the family of a sawmill operative who earned $1 a day in the mill, as did also each of his two sons. They paid $1.50 a month rent for their place, which contained 11 acres of poor mountain land, 10 acres of which were planted with corn and one with green vegetables.

The house contained two rooms and had two windows. One room served as a sleeping room for the entire family, and in the other they ate and cooked. The furniture was fairly good. The family dressed very poorly.

This study began August 24, 1904, and continued fourteen days. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 47 years, weight 177 pounds	42
Woman, age 50 years, weight 141 pounds (42 meals × 0.8 meal of man), equivalent to	34
Man, age 22 years, weight 170 pounds	42
Boy, age 17 years, weight 159 pounds	42
Girl, age 15 years, weight 140 pounds (42 meals × 0.7 meal of man), equivalent to	29
Girl, age 10 years, weight 89 pounds (42 meals × 0.6 meal of man), equivalent to	25
Total number of meals equivalent to	214

Equivalent to 1 man for 71 days.

Weights and cost of food and nutrients in dietary study No. 655.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 3.19 pounds, 32 cents (12); salt, 9 pounds, 90 cents (14)	1.22	1.7	4	63	....	577
Total animal food	1.22	1.7	4	63	....	577
VEGETABLE FOOD.						
Cereals: Corn meal, 37 pounds, 44 cents (33); flour, 54.5 pounds, $1.31 (37)	1.75	2.5	53	13	427	2,036
Sugars, etc.: Sugar, brown, 6 pounds, 30 cents (44)	.30	.4	....	....	36	144
Total vegetable food	2.05	2.9	53	13	463	2,180
Total food	3.27	4.6	57	76	463	2,757
Food wasted	....	....	....	....	1	4
Food actually eaten	3.27	4.6	57	76	462	2,753

The general character of this dietary is very similar to the preceding one, except that it is a little more generous in all respects; nevertheless, it still ranks among the poorest. Here again the family were in comparatively easy circumstances and had no apparent need of living so cheaply (4.6 cents per day). With vegetables ripening in their own garden, they might easily have obtained more variety in their food if they had craved it. It seems almost impossible that they should have been properly nourished with 57 grams of protein and 2,753 calories of energy per man per day, but equally impossible that they should have felt much discomfort. The children weigh noticeably more than the average for their ages.

DIETARY STUDY No. 656.

This study was made with a pensioner and his wife, who received $10 per month and who lived on a rented place for which they paid $2 per month. The lot contained 4 acres of very good land, which was planted in corn and beans the year of the study. Their home was the typical log cabin of this vicinity.

This study began August 10, 1904, and continued fourteen days. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 55 years, weight 180 pounds	42
Woman, age 52 years, weight 153 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	76

Equivalent to 1 man for 25 days.

Weights and cost of food and nutrients in dietary study No. 656.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 1.5 pounds, 15 cents (12)	0.15	0.6	....	27	....	240
Total animal food	.15	.6	....	27	....	240
VEGETABLE FOOD.						
Cereals: Corn meal, 15.19 pounds, 18 cents (33); flour, 18 pounds, 43 cents (37)	.61	2.4	50	15	436	2,078
Sugars, etc.: Sugar, brown, 2.31 pounds, 12 cents (44)	.12	.5	....	....	40	160
Total vegetable food	.73	2.9	50	15	476	2,238
Total food	.88	3.5	50	42	476	2,478
Food wasted	....	....	....	....	2	8
Food actually eaten	.88	3.5	50	42	474	2,470

This dietary is the cheapest of all those studied; it also ranks among the poorest in nutritive value, although it supplies more nutrients for less money than No. 658 and possibly No. 657. It is peculiar in that there is no animal food but lard; preparations of corn meal and wheat flour and a little brown sugar were the only articles used. It supplied 50 grams of protein and 2,470 calories of energy, or about half the protein and five-sixths of the energy required by the standard for light muscular work. Although probably neither the man nor his wife did very hard work, it seems likely that their food was insufficient according to the common standard. On the other hand, they obtained better returns in nutrients for the money expended than most, because they depended on the cheap cereal foods rather than on the more expensive pork for their protein.

DIETARY STUDY No. 657.

The head of the family here studied kept a store for dry goods, coal oil, and household goods. Besides his home place, which contained 70 acres of poor land and 10 acres of timber land, a log house, and a large barn, together valued at $300, he owned a sawmill, two horses, two cows, and twelve ducks. The house had three rooms, one used as a living or sleeping room, another as kitchen and dining room, while the third was reserved for the store (Pl. IV, fig. 1).

The weights and ages of the family, and the number of meals taken, follow.

FIG. 1.—HOME OF STOREKEEPER. DIETARY STUDY NO. 657.

FIG. 2.—HOME OF SAWMILL OPERATIVE. DIETARY STUDY NO. 658.

	Meals.
Man, age 36 years, weight 158 pounds	42
Woman, age 32 years, weight 161 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 10 years, weight 80 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 7 years, weight 50 pounds (42 meals × 0.5 meal of man), equivalent to	21
Girl, age 1½ years, weight 25 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	135

Equivalent to 1 man for 45 days.

Weights and cost of food and nutrients in dietary study No. 657.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Lard, 3.5 pounds, 25 cents (12)	0.25	0.6		34		303
Total animal food	.25	.6		34		303
VEGETABLE FOOD.						
Cereals: Corn meal, 18 pounds, 22 cents (33); flour, 37 pounds, 89 cents (37)	1.11	2.5	51	11	410	1,992
Sugars, etc.: Sugar, granulated, 3 pounds, 18 cents (45)	.18	.4			30	123
Vegetables: Beans, string, 13.25 pounds, 18 cents, (47); onions, 2 pounds, 4 cents (57); potatoes, white, 43 per cent refuse, 10 pounds, 13 cents (62); potatoes, sweet, 24 per cent refuse, 8.5 pounds, 9 cents (68)	.44	1.0	5	1	40	193
Total vegetable food	1.73	3.9	56	12	480	2,308
Total food	1.98	4.5	56	46	480	2,611
Food wasted					2	8
Food actually eaten	1.98	4.5	56	46	478	2,603

This dietary also ranks among the cheapest and poorest. Both the protein (56 grams) and the energy (2,611 calories) supplied are far below the average for these studies as well as below the standard for light muscular work. The diet was practically vegetarian, lard being the only animal product in it. Corn meal and flour were the main foods used, but there was an unusual variety of fresh vegetables as well. The amount of nutrients supplied compares very favorably with those in other studies where the cost was equally low, and the use of fresh vegetables made this diet much less monotonous than most of those in this series, even where considerably more money was expended. That this diet was sufficient for the best development of the family seems doubtful, but here, as in many of these studies, the children are of fully normal weight, and there is no reason to suppose that the family found the fare especially irksome.

DIETARY STUDY No. 658.

This study was made in the family of a sawmill operative. The man earned $1 a day at the mill and had steady work. He rented the house in which he lived for $1 a month. There were about 50 acres of land in the farm, which were not cultivated. The family lived in a log house with one room (Pl. IV, fig. 2); in it were two large beds, three rough chairs, one small dining table with an oilcloth cover, an old cook stove, and a large fireplace.

The study began August 24, 1904, and continued fourteen days with 42 meals. The members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 27 years, weight 180 pounds	42
Woman, age 19 years, weight 130 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 14 months, weight 16 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	89

Equivalent to 1 man for 30 days.

Weights and cost of food and nutrients in dietary study No. 658.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 1.5 pounds, 15 cents (12); salt, 5 pounds, 50 cents (14)	*Dollars.* 0.65	*Cents.* 2.3	*Grams.* 6	*Grams.* 81	*Grams.*	*Calories.* 745
Total animal food	.65	2.3	6	81	....	745
VEGETABLE FOOD.						
Cereals: Corn meal, 10 pounds, 12 cents (33); flour, 18 pounds, 43 cents (37)	.55	1.9	40	9	322	1,528
Sugars, etc.: Sugar, brown, 3 pounds, 15 cents (44)	.15	.5	....	....	45	180
Total vegetable food	.70	2.4	40	9	367	1,708
Food actually eaten	1.35	4.7	46	90	367	2,453

The amount of protein (46 grams) supplied by the diet here reported is without any exception the smallest in any of these studies. The study also ranks as the very lowest in regard to the energy (2,453 calories) supplied. The cost was almost exactly the same as in the preceding one, 4.5 cents; the food included a little salt pork in the place of part of the cereals, which brought up the price without an equivalent return in protein and carbohydrates; the amount of fat supplied is, however, larger than in dietary study No. 657. What has been said concerning the adequacy of the diets in the last few studies applies also here, save that in this case the weight of the child was slightly below the normal.

DIETARY STUDY No. 659.

The family here studied consisted of a widow and three daughters. They made their living by selling vegetables which they raised in a garden of an acre and a half. They lived in an old log house of two rooms, simply furnished.

The study began September 7, 1904, and continued fourteen days with 42 meals. The members of the family, and the number of meals taken, were as follows:

	Meals.
Woman, age 53 years, weight 141 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 23 years, weight 136 pounds (42 meals × 0.8 meal of man), equivalent to	34
Woman, age 19 years, weight 147 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 10 years, weight 87 pounds (42 meals × 0.6 meal of man), equivalent to	25
Total number of meals equivalent to	127
Equivalent to 1 man for 42 days.	

Weights and cost of food and nutrients in dietary study No. 659.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 3.06 pounds, 30 cents (12); salt, 9.44 pounds, 94 cents (14)	*Dollars.* 1.24	*Cents.* 2.9	*Grams.* 8	*Grams.* 108	*Grams.*	*Calories.* 993
Total animal food	1.24	2.9	8	108		993
VEGETABLE FOOD.						
Cereals: Corn meal, 21.5 pounds, 26 cents (33); flour, 39 pounds, 94 cents (37)	1.20	2.9	60	14	481	2,289
Total vegetable food	1.20	2.9	60	14	481	2,289
Food actually eaten	2.44	5.8	68	122	481	3,282

This dietary is in all respects slightly poorer than the average, although it supplied more nutrients and cost more than the last six or seven reported. The most noticeable feature is perhaps the comparatively large amount of fat, 122 grams, in proportion to the other nutrients, which brings up the fuel value to 3,282 calories, about the amount called for by the standard for moderate muscular work. The protein (68 grams), on the other hand, is about one-half that required by that standard. The muscular labor required for the cultivation of the vegetable garden by which these women earned their living would probably amount to that indicated by this standard. The cost of this diet, 5.8 cents, is about the same as that in

study No. 652, which was that of a widow living alone; in that case more protein, but less energy, was supplied, a difference due to the use of milk in the place of the pork here consumed.

DIETARY STUDY No. 660.

The man in whose family this study was made worked out as a farm hand, and his income, therefore, varied with the season. He owned the little hilly farm on which they lived and cultivated a good-sized vegetable garden. The house was built of logs and contained two rooms with no windows.

This study began September 7, 1904, and continued fourteen days. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 32 years, weight 160 pounds	42
Woman, age 23 years, weight 138 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 8 months, weight 32 pounds (42 meals × 0.3 meal of man), equivalent to	13
Total number of meals equivalent to	89

Equivalent to 1 man for 29 days.

Weights and cost of food and nutrients in dietary study No. 660.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 3.31 pounds, 33 cents (12); salt, 11 pounds, $1.10 (14)	*Dollars.* 1.43	*Cents.* 4.7	*Grams.* 13	*Grams.* 172	*Grams.*	*Calories.* 1,583
Total animal food	1.43	4.7	13	172	....	1,583
VEGETABLE FOOD.						
Cereals: Corn meal, 29 pounds, 35 cents (33); flour, 21.5 pounds, 52 cents (37)	.87	2.9	66	22	542	2,628
Sugars, etc.: Molasses, 7 pounds, 21 cents (43)	.21	.7	3	....	73	304
Total vegetable food	1.08	3.6	69	22	615	2,932
Food actually eaten	2.51	8.3	82	194	615	4,515

The protein supplied by the diet here reported (82 grams) is slightly above the average for these studies. The amounts of fat and carbohydrates are even greater in proportion, and the total energy is 4,515 calories, or about one-third more than that called for by the standard for moderate muscular work, such as that performed by the man of the family. The cost of the food, 8.3 cents, is high for this series, and almost as high as the average for the town studies, 8.7 cents. This diet furnished protein as cheaply as the majority, and energy more cheaply, but there was no variety obtained with the extra price, the fare being the simple "hog and hominy" typical of the region.

DIETARY STUDY No. 661.

The family whose dietary is here reported consisted of a sawmill operative, his wife, and three children. The man earned 75 cents a day at the mill. He owned his place, which was valued at $60, and a cow worth $18. There were 2 acres of good land in the lot; one-half of this was a garden, where several kinds of vegetables were raised. The house was an old log house with two rooms fairly well furnished, according to local standards.

This study began September 7, 1904, and continued fourteen days. The members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 38 years, weight 154 pounds	42
Woman, age 26 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 7 years, weight 61 pounds (42 meals × 0.5 meal of man), equivalent to	21
Boy, age 5 years, weight 40 pounds (42 meals × 0.4 meal of man), equivalent to	17
Boy, age 2 years, weight 29 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	131
Equivalent to 1 man for 44 days.	

Weights and cost of food and nutrients in dietary study No. 661.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 3.44 pounds, 34 cents (12); salt, 7 pounds, 70 cents (14)	*Dollars.* 1.04	*Cents.* 2.4	*Grams.* 6	*Grams.* 90	*Grams.*	*Calories.* 825
Dairy products: Butter, 3.06 pounds, 60 cents (21); buttermilk, 30 pounds, 19 cents (25); milk, skimmed, 18 pounds, 14 cents (31)	.93	2.2	16	29	20	402
Total animal food	1.97	4.6	22	119	20	1,227
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents (33); flour, 41 pounds, 98 cents (37)	1.22	2.8	60	13	476	2,262
Sugars, etc.: Molasses, 8 pounds, 24 cents (43)	.24	.6	2		58	240
Total vegetable food	1.46	3.4	62	13	534	2,502
Total food	3.43	8.0	84	132	554	3,729
Food wasted					1	4
Food actually eaten	3.43	8.0	84	132	553	3,725

The daily supply of protein in this diet, 84 grams, is slightly higher than the average for this series, but noticeably lower than the standard even for persons without muscular work. The energy, however, is more than that called for by the standard for moderately active

muscular work. The cost is relatively low, especially considering the variety of dairy products used. Except for the latter, the diet shows only five articles of food. With a vegetable garden of their own these people could undoubtedly have had a greater variety for very little extra cost, and could probably have afforded it if they had wished it.

DIETARY STUDY No. 662.

This study was made in the family of a farmer who owned 126 acres of good land, valued at $1,500, and who worked on the place himself, raising corn and wheat. He also owned two cows, three good mules, and good wagons, tools, and outhouses.

The house was a frame building of three rooms, unusually well furnished; one room served as bedroom, another as dining room, and the third as kitchen. The house was in every way better than was usual in this region. The wife did the housework, and the children went to school.

The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 37 years, weight 176 pounds	42
Woman, age 28 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 10 years, weight 90 pounds (42 meals × 0.6 meal of man), equivalent to	25
Boy, age 6 years, weight 60 pounds (42 meals × 0.5 meal of man), equivalent to	21
Total number of meals equivalent to	122

Equivalent to 1 man for 41 days.

Weights and cost of food and nutrients in dietary study No. 662.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Salt, 9 pounds, 90 cents (14)	0.90	2.2	8	73	....	682
Dairy products: Butter, 3 pounds, 30 cents (21); buttermilk, 20 pounds, 13 cents (25); milk, skimmed, 37 pounds, 28 cents (31)	.71	1.7	21	30	28	463
Total animal food	1.61	3.9	29	103	28	1,145
VEGETABLE FOOD.						
Cereals: Corn meal, 39.31 pounds, 47 cents (33); flour, 57 pounds, $1.37 (37)	1.84	4.5	96	24	777	3,706
Total vegetable food	1.84	4.5	96	24	777	3,706
Total food	3.45	8.4	125	127	805	4,851
Food wasted	....	....	....	....	1	4
Food actually eaten	3.45	8.4	125	127	804	4,847

This is one of the few dietary studies in which the protein supplied (125 grams) equals the amount required by the standard for moderate muscular work. It shows, however, a considerable excess of the energy-producing foods, especially of carbohydrates, having a fuel value of 4,847 calories, about 1,500 more than the standard. Dairy products were used by this family, and also an unusually large amount of cereals. The cost was 8.4 cents, slightly higher than in the majority of these studies. In respect to amount and proportion of nutrients and real economy as judged by ordinary standards, this diet is one of the best of the seventy here reported. The children were both heavy for their age.

DIETARY STUDY No. 663.

This study was made in the family of a sawmill operative who earned 75 cents a day. They lived in the two rear rooms of a four-room frame house (see study No. 665) which they rented for $1 a month.

This study began September 21, 1904, and continued fourteen days. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 20 years, weight 150 pounds	42
Woman, age 18 years, weight 147 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 2 years, weight 37 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	93

Equivalent to 1 man for 31 days.

Weights and cost of food and nutrients in dietary study No. 663.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Salt, 7.5 pounds, 75 cents (14)	0.75	2.4	9	80	....	748
Total animal food	.75	2.4	9	80	....	748
VEGETABLE FOOD.						
Cereals: Corn meal, 20 pounds, 24 cents (33); flour, 27 pounds, 65 cents (37)	.89	2.9	62	16	500	2,390
Vegetables: Beans, dried, 3 pounds, 15 cents (48); potatoes, white, 29 per cent refuse, 19 pounds, 24 cents (62); sauerkraut, 19 pounds, 38 cents (67)	.77	2.5	18	2	74	386
Total vegetable food	1.66	5.4	80	18	574	2,776
Food actually eaten	2.41	7.8	89	98	574	3,524

Eighty-nine grams of protein were supplied in this dietary, 7 grams more than the average. The fat consumed is a little less than usual, but the carbohydrates run higher than in most cases, so that the total

energy, 3,524 calories, is not much below the average for this series and slightly below the average for all the studies and slightly above the standard for moderate muscular work. The food cost 7.8 cents, slightly more than the average for this series, but less than the total average for all three series. Its chief peculiarity lies in the variety of vegetables which it contains; dried beans, it may be noted, furnished as much protein as salt pork, the only animal food in the list. While it is deficient in protein as judged by the usual standard, it furnishes an excellent example of the better type of the present studies.

DIETARY STUDY No. 664.

This study was made in the family of a farmer who earned $15 a month cultivating a large farm for another man. He owned his place, valued at $500, and cultivated 30 of his 90 acres of land, raising corn, sweet potatoes, and white potatoes. He owned two mules, worth $90 each, a buggy, and a wagon. He and his wife lived alone in a frame house of two rooms.

The study began September 21, 1904, and continued fourteen days. The members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 67 years, weight 150 pounds	42
Woman, age 59 years, weight 136 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	76

Equivalent to 1 man for 25 days.

Weights and cost of food and nutrients in dietary study No. 664.

Food consumed during the entire study (14 days). Kinds and amounts.	Cost.	Cost, nutrients, and fuel value of food per man per day. Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	Dollars.	Cents.	Grams.	Grams.	Grams.	Calories.
Pork: Salt, 10 pounds, $1 (14)	1.00	4.0	15	133	....	1,244
Dairy products: Butter, 3.56 pounds, 71 cents (21)	.71	2.8	1	53	....	476
Total animal food	1.71	6.8	16	186	....	1,720
VEGETABLE FOOD.						
Cereals: Flour, 20 pounds, 48 cents (37)	.48	1.9	37	4	282	1,312
Vegetables: Beans, dried, 6 pounds, 30 cents (48)	.30	1.2	22	2	68	378
Total vegetable food	.78	3.1	59	6	350	1,690
Food actually eaten	2.49	9.9	75	192	350	3,410

This dietary furnishes smaller amounts of nutrients for the money expended than any other here studied. The cost, 9.9 cents, is 2.5 cents above the average for the present series and 1.1 cents above that for all the studies. The protein supplied is only 75 grams, 7

grams less than the average, while the energy, 3,410 calories, is 300 calories below the average for this series and about 250 below that for the 63 studies. The amount of carbohydrates is the very lowest of all the studies. These peculiarities seem due to the fact that butter is used in the place of lard, and that no corn meal and not very great quantities of wheat flour are included. The deficiency in protein is especially surprising because considerable quantities of dried beans are employed, an economical source of that expensive nutrient.

DIETARY STUDY No. 665.

This dietary is that of a farmer's family. The man owned 90 acres of good land valued at $300, and cultivated his farm. He owned two mules, a wagon, and a buggy, together valued at $200.

This family lived in the two front rooms of the frame house described in dietary study No. 663.

The study began September 21, 1904, and continued fourteen days. The ages and weights of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 64 years, weight 175 pounds	42
Woman, age 59 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	34
Girl, age 15 years, weight 97 pounds (42 meals × 0.8 meal of man), equivalent to	34
Boy, age 5 years, weight 41 pounds (42 meals × 0.4 meal of man), equivalent to	17
Total number of meals equivalent to	127

Equivalent to 1 man for 42 days.

Weights and cost of food and nutrients in dietary study No. 665.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 4.06 pounds, 40 cents (12); salt, 11 pounds, $1.10 (14)	*Dollars.* 1.50	*Cents.* 3.6	*Grams.* 9	*Grams.* 131	*Grams.*	*Calories.* 1,202
Dairy products: Butter, 3.19 pounds, 32 cents (21); buttermilk, 47 pounds, 29 cents (25); milk, skimmed, 58 pounds, 44 cents (31)	1.05	2.5	37	33	49	638
Total animal food	2.55	6.1	46	164	49	1,840
VEGETABLE FOOD.						
Cereals: Corn meal, 31 pounds, 37 cents (33); flour, 47.5 pounds, $1.14 (37)	1.51	3.6	77	19	620	2,957
Sugars, etc.: Sugar, granulated, 4.31 pounds, 26 cents (45)	.26	.6	....	....	46	184
Total vegetable food	1.77	4.2	77	19	666	3,141
Food actually eaten	4.32	10.3	123	183	716	4,981

The amount of protein furnished in this, 123 grams, is one of the highest reported in the seventy studies, and is a trifle greater than the standard for moderate muscular work; it is about 50 per cent higher than the average for these studies. The amount of energy supplied is also notably in excess of both the average and the standard, but this difference is not so unusual as in the case of the protein. The cost is 10.3 cents, 3 cents more than the average for the present series and 1.5 cents more than the general average. These differences in cost and amount of nutrients seem to be due to the use of dairy products and unusually large quantities of the other food materials. Dietary studies Nos. 640 and 662 reported as large amounts of protein and rather better proportions of energy at slightly less cost, but otherwise the present diet is among the best of all the series. According to the generally accepted standards, its chief weakness is the excess of fats and carbohydrates.

DIETARY STUDY No. 666.

The subjects of this study were a laborer and his wife. The man earned 50 cents a day clearing land. They paid $1 a month rent for 70 acres of timber land, a garden lot, and a log house of one room. Their furniture consisted of two large beds, a small dining table, a small clock, a trunk, and four rough chairs. The cooking was done in the fireplace. They owned no live stock.

This study began September 21, 1904, and continued fourteen days. The members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 38 years, weight 178 pounds	42
Woman, age 32 years, weight 161 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	76

Equivalent to 1 man for 25 days.

Weights and cost of food and nutrients in dietary study No. 666.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Salt, 14 pounds, $1.40 (14)	1.40	5.6	20	186	....	1,735
Total animal food	1.40	5.6	20	186	....	1,735
VEGETABLE FOOD.						
Cereals: Corn meal, 41 pounds, 49 cents (33); flour, 25 pounds, 60 cents (37)	1.09	4.4	101	36	843	4,096
Vegetables: Beans, butter, 1 pound, 10 cents (46)	.10	.4	2	....	5	28
Total vegetable food	1.19	4.8	103	36	848	4,124
Total food	2.59	10.4	123	222	848	5,859
Food wasted	......	....	....	....	3	12
Food actually eaten	2.59	10.4	123	222	845	5,847

The diet here reported has very much the same nutritive value as that described in the preceding study, save that it contains still larger quantities of fat and carbohydrates, with correspondingly greater fuel value, 5,847 calories. Its most striking feature is the amount of cereals, especially of corn meal, used, 101 grams of the total protein and 4,096 calories of the total energy coming from this source. The quantities of salt pork are also unusually large. The cost, 10.4 cents, is practically the same as in study No. 665. The diet in study No. 665 is, however, slightly superior, mainly because its fuel value is less excessive and because its dairy products gave it more variety, but No. 662 surpassed them both in economy as well as in the proportion of nutrients.

DIETARY STUDY No. 667.

This study was made in the family of a farmer regarding whose occupation and income little is reported. This family lived in a good frame house of five rooms, for which they paid $4 a month rent. The sitting room contained one large lounge, four rocking chairs, a book-case, and a small fireplace. There was a carpet on the floor, and the two windows had shades and curtains. Another room had two good beds, a small clock, three good chairs, a carpet, and two windows with shades and curtains. The third room was the dining room; in it were a small dining table with a linen cover, four good dining chairs, and two windows. The fourth room was the kitchen; there were in this room a cook stove, a small table used for dishes, a wood box, and two small windows with shades. The fifth room was a small room used for a storage room. There were 2 acres of land used for a garden, which was productive. The family owned a horse and buggy and a dog.

This study began September 24, 1904, and continued fourteen days. The members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 54 years, weight 167 pounds	42
Woman, age 56 years, weight 159 pounds (42 meals × 0.8 meal of man), equivalent to	34
Total number of meals equivalent to	76

Equivalent to 1 man for 25 days.

Weights and cost of food and nutrients in dietary study No. 667.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Lard, 3.31 pounds, 33 cents (12); salt, 6 pounds, 60 cents (14)	*Dollars.* 0.93	*Cents.* 3.7	*Grams.* 9	*Grams.* 140	*Grams.*	*Calories.* 1,282
Dairy products: Butter, 1.5 pounds, 30 cents (21)	.30	1.2	......	22	....	196
Total animal food	1.23	4.9	9	162	....	1,478
VEGETABLE FOOD.						
Cereals: Corn meal, 19 pounds, 23 cents (33); flour, 26.5 pounds, 64 cents (37)	.87	3.5	74	19	601	2,869
Fruits: Jelly, apple, 3 pounds, 30 cents (76)	.30	1.2	1	.....	42	172
Total vegetable food	1.17	4.7	75	19	643	3,041
Total food	2.40	9.6	84	181	643	4,519
Food wasted	...	...	...	...	3	12
Food actually eaten	2.40	9.6	84	181	640	4,507

This dietary shows a supply of protein, 84 grams, slightly higher than the average and noticeably higher fuel value, 4,507 calories. Its cost is 9.6, or 2.2 cents more than the average for these studies. Considering the amount of protein furnished, this sum seems unduly large; it is to be accounted for mainly by the butter and apple jelly used. This is the only one of the present series of studies where fruit in any form was found. Nothing was reported regarding the income of this family, but judging from the house in which they lived they were in unusually comfortable circumstances. Evidently, then, they can have been conscious of no discomfort from lack of quantity or variety in their food, and, as in several of the studies of this series, one is forced to conclude that habit makes it possible to live comfortably on a much simpler diet than is ordinarily considered palatable. The question of the deficiency in protein is the same here as in most of these studies and will be discussed in a later section.

SUMMARY OF THE STUDIES.

The table on page 105 gives the amounts of protein, fats, carbohydrates, and energy furnished per man per day in these studies, and also the cost of the food.

The results of study No. 626 were not included in calculating the averages for these studies because the cost and general character of the diet (see p. 57) are very unlike the others.

Leaving it out of consideration, the cost of food ranged from 3.5 cents to 15.9 cents per man per day, the protein supplied ran from 46 to 137 grams, and the energy from 2,453 to 5,847 calories per man per day.

Summary of results of dietary studies Nos. 604-667 on per man per day basis.

Dietary study.	Cost.	Protein.	Fats.	Carbohydrates.	Energy.
STUDIES NEAR TOWNS.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
No. 604	9.3	93	142	681	4,360
No. 605	6.4	80	60	446	2,638
No. 606	12.7	86	130	533	3,633
No. 607	6.5	99	95	504	3,257
Average of 4 studies	8.7	89	107	541	3,472
No. 608	8.7	60	93	420	2,747
No. 609	8.4	76	129	437	3,200
No. 610	10.5	83	84	518	3,151
No. 611	10.3	86	196	556	4,312
No. 612	9.4	115	102	484	3,303
No. 613	8.4	59	100	389	2,682
No. 614	9.9	88	137	497	3,559
No. 615	5.5	52	74	440	2,626
No. 616	6.3	81	52	472	2,675
No. 617	10.3	69	99	622	3,645
No. 618	6.6	83	99	598	3,605
No. 619	5.2	70	26	607	2,939
No. 620	10.8	77	103	635	3,765
No. 621	12.7	90	69	606	3,398
No. 622	11.0	107	155	654	4,423
No. 623	14.3	99	224	616	4,854
No. 624	10.5	101	101	547	3,491
No. 625	15.9	122	227	605	4,928
No. 626 [a]	24.2	124	332	743	6,423
No. 627	5.2	67	67	463	2,716
No. 628	7.7	79	101	488	3,167
No. 629	10.7	137	155	778	5,039
No. 630	9.3	81	135	503	3,537
No. 631	5.6	53	58	461	2,572
No. 632	13.7	90	108	707	4,149
No. 633	8.6	70	89	497	3,060
No. 634	10.0	85	162	673	4,474
No. 635	12.1	105	165	753	4,900
No. 636	7.6	72	104	517	3,282
No. 637	9.7	83	119	703	4,203
No. 638	11.0	116	178	803	5,260
No. 639	10.5	87	147	651	4,260
No. 640	9.8	124	127	643	4,198
No. 641	7.6	82	120	520	3,475
No. 642	10.2	87	124	687	4,200
No. 643	9.8	83	67	776	4,032
No. 644	6.5	73	123	433	3,119
No. 645	7.8	75	69	493	2,886
No. 646	7.5	59	147	402	3,152
No. 647	8.2	69	179	390	3,429
No. 648	9.1	86	153	648	4,297
Average of 40 studies	9.3	85	118	567	3,668
Average of 44 studies	9.3	85	117	565	3,650
STUDIES IN REMOTE DISTRICTS.					
No. 649	12.3	114	197	690	4,970
No. 650	9.5	91	145	574	3,951
No. 651	8.8	78	199	563	4,335
No. 652	5.9	82	64	458	2,730
No. 653	4.9	64	85	486	2,959
No. 654	5.3	59	79	485	2,880
No. 655	4.6	57	76	462	2,753
No. 656	3.5	50	42	474	2,470
No. 657	4.5	56	46	478	2,603
No. 658	4.7	46	90	367	2,453
No. 659	5.8	68	122	481	3,282
No. 660	8.7	84	200	636	4,660
No. 661	8.0	84	132	553	3,725
No. 662	8.4	125	127	804	4,847
No. 663	7.8	89	98	574	3,524
No. 664	9.9	75	192	350	3,410
No. 665	10.3	123	183	716	4,981
No. 666	10.4	123	222	845	5,847
No. 667	9.6	84	181	640	4,507
Average of 19 studies	7.4	82	131	560	3,731
Average of 63 studies	8.8	84	121	563	3,674

[a] Omitted from average.

COST OF NUTRIENTS AND ENERGY.

One of the most interesting points brought out in the table(p. 105) is the relation of the cost of food to the condition of the family and to the amount of nutrients and energy supplied.

The occupation of the wage-earners apparently has little effect upon either the amount or the kind of food purchased; the best-nourished families were by no means those in which the men did the severest work, nor do the families of farmers who cultivate their own land, including gardens, use as a rule a greater variety of vegetables than those who must pay cash for all their supplies.

There also seems to be little connection between the size of the income and the amount spent for food. The money thus used can not, of course, exceed the income, but in many cases the families in the best financial condition spent very little for food, while those of very poor means often spent more than the average. Of the four diets which cost less than 5 cents per person per day none were from families described as poor. Two were undoubtedly in good circumstances. Exclusive of the families whose condition was not determined, there were seventeen who paid 10 cents or more for their food, and only one of these is ranked as good, while three rank as poor. The average cost among those classed as poor is 8.2 cents, among all, 8.8 cents. Evidently, then, extreme poverty does not tend to reduce the cost of food in all cases, but comparatively easy circumstances do not raise it above the average. These facts are especially noticeable in the studies made in the remote districts.

But if there is no fixed relation between the cost of food and the income, there is a certain degree of uniformity between the amount spent and the nutrients and energy obtained. This can not, of course, be demonstrated in every individual case, but there is a decided tendency in the dietaries to show more protein and energy where more money is expended.

In only 12 of the studies included in computing average results did the amount of protein supplied per man per day exceed 100 grams; the lowest cost in these studies was 8.4 cents, but in all of them except this one the cost exceeded 9.3 cents. In the 33 studies in which the cost was less than this, ranging from 9.1 to 3.5 cents, an average of 72 grams of protein was supplied at an average cost of 6.8 cents. In the 30 dietaries in which the cost was higher, an average expenditure of 11.2 cents furnished 97 grams of protein.

In considering the amount of energy obtained for the money spent, it will be convenient to use the same sum, 9.2 cents, as the dividing line. In only three cases where the cost was as much as or more than that did the energy fall below 3,400 calories. None contained less

than 3,000 calories, while the average was 4,306 calories. In only 12 of the dietaries costing less than 9.2 cents did the fuel value equal 3,400 calories, while the average of the 33 is 3,174 calories.

The economy of the individual dietaries in regard to the amount of protein and energy obtained was discussed in connection with each study. Certain general features, however, may be mentioned here, especially the difference between the studies in different regions.

In the studies made in remote districts, the average cost was 7.4 cents, 1.9 cents less than in the earlier or urban ones. The amount of protein averaged 85 grams in the first group and 82 grams in the second. More energy, however, was found in the last series, where it averaged 3,731 calories as against 3,668 calories in the urban studies. This increased energy is due to greater amounts of both fats and carbohydrates, obtained from larger proportions of fat pork and cereals; or, to state it inversely, to the most restricted use of lean meats, fruist, and vegetables. These mountain diets are evidently more economical, since they furnish as much protein and more energy for less money. On the other hand, they may furnish more energy than the families require; but such points will be discussed in a later section (see p. 108). They also are even less varied than the village dietaries studied, which themselves would seem distasteful to anyone not accustomed to them. A general survey of all the studies tends to confirm the conclusion suggested by the individual studies, that habit has much to do with the variety of food desired, and that people accustomed for years or generations to eating only a few kinds of food, as are the families in these studies, can relish a diet which would be irksome or even repellent to those accustomed to different ways of living. In several cases where the diet consisted of only three or four articles, the families were undoubtedly quite able to afford more variety had they craved it.

One further point in regard to these remote mountain studies is worth mentioning. Skim milk and buttermilk were found in six of the nineteen dietaries. The average amount of protein supplied in these six was 103 grams, 23 grams more than the average. The cost averaged 9.2 cents, 1.8 cents more than the general average of this series, and 0.1 cent less than the average of all the studies. In study No. 652 the dairy products were the only animal foods used, and the dietary furnished 82 grams of protein at a cost of 5.9 cents. If these figures are sufficient for drawing a conclusion, it is that a freer use of such inexpensive dairy products would be an easy and economical means of increasing the protein in these diets. The use of milk in the village diets also shows an increased amount of protein at a slight increase of cost and might well be made more general.

PECULIARITIES OF THE DIET.

These studies fully confirm the popular impression that the diet among the people of whom these families are typical is extremely simple and cheap and unattractive, judged by the usual standards. Corn meal, wheat flour, and fat, cured pork are the principal kinds of food, to which a few other materials are added in varying proportion. In general, it may be said that these three items make up about three-quarters of the total diet. There is, on the whole, more variety among families living in or near the towns than in remote mountain districts. These differences are probably mainly due to differences in the buying facilities in the various sections. Even the most varied of these diets, however, are much simpler than the majority of those of families elsewhere observed.

Of the animal foods, pork is by far the most common, and in the majority of cases it is used cured or salted. Beef was found in nineteen of the sixty-four studies, fish in two, and poultry in none. Game is reported three times, but very likely it would have occurred more frequently if all the studies had been made in the hunting season. Only eight families used eggs, although they were comparatively cheap when many of the studies were carried on. Buttermilk was more commonly used than in any similar studies; skim milk was also in fairly common use, but whole milk appears in only nine cases. In general, milk was most freely consumed in families where a cow was kept. Butter was fairly common, especially in the town series. The reports for the series of studies made in the mountain districts show even less variety among the animal foods than the others. Salt pork was the only meat eaten. No fish, eggs, or whole milk were used, and lard ordinarily replaced butter.

The most common vegetables were white and sweet potatoes, but beans, both dried and fresh, cabbage, turnips, onions, tomatoes, etc., are occasionally seen in the lists. Fresh fruits appear to be little used, even in summer. Dried, canned, and jellied fruits are mentioned occasionally, sometimes in forms peculiar to the locality, such as dried gooseberries and blackberries. The dietaries from the mountain districts show a greater variety of vegetable than of animal foods, but even here the village dietaries surpassed them. Apple jelly, used in study No. 667, is the only mention of the use of such fruit in the mountain studies.

No account was taken of condiments, but there was certainly no great variety or amount of them in any of the dietaries.

There are no data to show how the raw food was prepared. An ingenious housewife could undoubtedly add considerably to the variety of the meals by different ways of cooking and serving, but

when one recalls how many of the houses were lacking in all conveniences and how simple the general scale of living was, it seems probable that the food was usually cooked and served in the quickest, simplest way. Judging from the amounts of lard used, much of the food was fried.

Several of the prominent features of these dietaries are brought out in the following table, which gives the percentages of protein and energy derived from the total animal and vegetable foods in each study, and also from pork (including lard) and from corn meal and wheat flour:

Proportions of protein and energy derived from different food materials in dietary studies Nos. 604–667.

[Data on basis of food purchased. Quantities per man per day.]

Dietary study.	Total animal food.		Total vegetable food.		Pork.		Corn meal and wheat flour.	
	Protein.	Energy.	Protein.	Energy.	Protein.	Energy.	Protein.	Energy.
STUDIES NEAR TOWNS.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
No. 604	16	27	84	73	9	26	71	58
No. 605	37	24	63	76	8	11	55	66
No. 606	41	33	59	67	20	20	[a] 50	[a] 45
No. 607	44	32	56	68	11	20	55	67
No. 608	25	31	75	69	8	16	48	38
No. 609	17	35	83	65	12	33	[a] 50	[a] 44
No. 610	15	24	85	76	2	12	54	50
No. 611	25	37	75	63	18	31	[a] 67	[a] 55
No. 612	60	34	40	66	26	21	32	41
No. 613	27	35	73	65	5	21	60	50
No. 614	34	35	66	65	23	25	48	47
No. 615	11	23	89	77	11	17	83	62
No. 616	24	18	76	82	10	15	65	73
No. 617	9	22	91	78	9	18	86	60
No. 618	14	21	86	79	9	17	[b] 77	[b] 73
No. 619	(c)	4	100	96	(c)	4	80	71
No. 620	15	23	85	77	8	20	[b] 77	[b] 59
No. 621	22	18	78	82	....	....	65	68
No. 622	25	29	75	71	10	21	45	48
No. 623	35	41	65	59	19	27	54	46
No. 624	41	28	59	72	15	13	46	57
No. 625[d]	42	44	58	56	12	26	34	36
No. 626	45	50	55	50	8	32	47	36
No. 627	9	15	91	85	7	14	57	62
No. 628	22	27	78	73	10	20	60	58
No. 629	26	28	74	72	6	23	58	60
No. 630	26	32	74	68	15	30	64	57
No. 631	13	17	87	83	7	16	85	68
No. 632	17	22	83	78	6	14	72	59
No. 633	24	26	76	74	(c)	5	71	62
No. 634	12	29	88	71	10	20	87	64
No. 635	23	29	77	71	10	19	75	60
No. 636	21	27	79	73	8	21	74	61
No. 637	19	23	81	77	11	14	70	55
No. 638	15	27	85	73	8	19	77	65
No. 639	7	28	93	72	6	18	73	56
No. 640	44	30	56	70	36	28	46	51
No. 641	33	31	67	69	28	29	63	58
No. 642	17	25	83	75	7	18	60	46
No. 643	13	13	87	87	6	5	77	61
No. 644	26	34	74	66	12	32	72	64
No. 645	26	21	74	79	1	11	64	62
No. 646	31	43	69	57	7	31	69	49
No. 647	27	45	73	55	27	45	64	49
No. 648	16	29	84	71	10	25	83	64
Average of 44 studies	24	27	76	73	11	20	65	58

[a] Includes also corn bread, wheat bread, or both.
[b] Includes also hominy.
(c) Less than 0.5 per cent.
[d] Not included in average. See p. 104.

Proportions of protein and energy derived from different food materials in dietary studies Nos. 604–667—Continued.

Dietary study.	Total animal food.		Total vegetable food.		Pork.		Corn meal and wheat flour.	
	Protein.	Energy.	Protein.	Energy.	Protein.	Energy.	Protein.	Energy.
STUDIES IN REMOTE DISTRICTS.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
No. 649	35	39	65	61	6	22	60	52
No. 650	30	35	70	65	4	21	59	53
No. 651	9	38	91	62	9	38	86	59
No. 652	42	24	58	76	....	....	52	70
No. 653	8	22	92	78	8	22	92	76
No. 654	5	20	95	80	5	20	92	73
No. 655	7	21	93	79	7	21	93	74
No. 656	(a)	10	100	90	(a)	10	100	84
No. 657	(a)	12	100	88	(a)	12	91	77
No. 658	13	30	87	70	13	30	87	62
No. 659	12	30	88	70	12	30	88	70
No. 660	16	35	84	65	16	35	81	58
No. 661	26	33	74	67	7	22	71	76
No. 662	23	24	77	76	6	14	77	76
No. 663	10	21	90	79	10	21	70	68
No. 664	21	50	79	50	20	37	49	39
No. 665	37	37	63	63	7	24	63	59
No. 666	16	30	84	70	16	30	82	70
No. 667	12	33	88	67	11	29	88	64
Average of 19 studies	17	29	83	71	8	23	78	66
Average of 63 studies	22	28	78	72	10	21	69	60

a Includes also corn bread, wheat bread, or both.

In discussing this table it may be interesting to recall the proportions of protein and energy usually supplied by the different classes of food; they have been estimated from the averages of 185 dietary studies made throughout the United States among persons of different circumstances and occupations, and are as follows:

Proportions of protein and energy supplied by certain foods in average American diets.

Kind of food material.	Protein.	Energy.	Kind of food material.	Protein.	Energy.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Total animal food	61	64	Total vegetable food	39	36
Total meat and fish	43	37	Cereal products	31	24
Pork	9	18			

In none of the present studies do the animal foods furnish as large a proportion of protein as in the figures just quoted, 61 per cent. The average for the 63 studies is 22 per cent, and for the 19 studies in the Crooked Creek region, 17 per cent. In only 8 of the 63 is more than 40 per cent of the protein furnished by animal foods, while 3 show less than 5 per cent. In fact, a little lard is all that distinguishes these 3 from purely vegetarian diets. Whereas in the ordinary diet fat pork supplies one-seventh of the protein of animal origin, in these studies it furnishes one-half. The proportion of protein supplied by all kinds of meats in these studies has not been

calculated, but it must be considerably less than half as much as is found in the general averages; in fact, the total animal protein in these studies is about one-half of that ordinarily supplied by meats alone. About 64 per cent of the energy of the average diet comes from animal foods, while in these studies the proportion is only 28 per cent, and this energy, like the protein, comes mainly from pork. But whereas pork furnishes about one-half of the animal protein, it furnishes three-quarters of the energy of animal origin; this large divergence is of course due to the lard which is included with the other forms of pork.

The small proportion of nutrients of animal origin in these dietaries of course indicates a correspondingly large proportion of vegetable nutrients. In the average diet 38.8 per cent of the protein is of vegetable origin; in these studies, 78 per cent. This excess is due mainly to cereals, of which corn meal and wheat flour are by far the most common. These two items furnish 69 per cent of the protein of all the dietaries and 78 per cent in the last 19 studies. In the ordinary diet all the cereals together supply only 31 per cent.

The proportion of energy supplied by the vegetable foods in these studies is 72 per cent, as against 36 per cent in the average of the 185 dietaries—just twice as great. All the cereals in the average diet yield 24 per cent of the energy, while in these studies corn meal and wheat flour alone furnish 69 per cent. In the practically vegetarian diets already referred to, and in others where the animal food is especially scanty, the proportions of nutrients and energy furnished by vegetable foods are, of course, correspondingly larger.

ADEQUACY OF THE DIETS.

In attempting to compare the results of dietary studies with commonly accepted dietary standards, and indeed to establish such standards in the first place, several difficulties necessarily arise. The standards themselves are only tentative, because they can be based only on the available dietary studies and more abstract physiological research hitherto accomplished and must be subject to change whenever new information may show that modification is necessary. Moreover, individual physiological peculiarities and dietary habits, as well as muscular activity, have so much effect on the demands of the body for nourishment that it is extremely difficult to determine what are the needs of even normal healthy persons at work requiring different degrees of muscular activity. The standards, therefore, can not be absolutely applied as measures of physiological requirements for each day or week to individual dietaries or even large groups of dietaries as indicating the exact amounts of nutrients required. They are intended simply to indicate what, in the light of our pres-

ent limited knowledge, seem to be the best amounts of nutrients for normal persons and to serve as guides in providing the food for families and groups when the problem is considered for long periods.

During the last few years there has been much discussion regarding the protein requirements of the body, and it has been maintained by some investigators that the ordinary standards indicate an amount considerably larger than is actually needed. This theory is based on the fact that the nitrogen equilibrium of the body has been maintained, together with excellent physical condition, by subjects living for months on diets poor in protein. Certain Asiatic and European races, commonly said to have existed for years on diets containing little nitrogenous food, are further cited as bearing out the contention. Recent investigations made among exactly such people, Bengalis, near Calcutta, India, throw most interesting light on the subject.[a]

From minute and painstaking observations on typical groups of Bengalis and others, including statistics of diet, urine and blood analyses, physical measurements, endurance tests, etc., the conclusion is drawn that while the Bengalis exist comfortably on food supplying about one-third of the standard amount of protein, and while their height is similar to that of Europeans, their weight, chest measurements, and muscular development are inferior to those of Europeans living in the same climate, or of Asiatics whose dietary habits give them a larger protein supply. Moreover, numerous blood and urine tests indicate a condition less able to resist disease, a condition recognized by Indian insurance companies, which charge much higher rates and insist on severer tests for Bengalis than for Europeans. Further statistics are quoted showing that in such labor as that in coal mines the output of a Bengali is only 27 per cent of that of a European. The author also insists, on the basis of his results, that, while diseases caused by excess of urea and uric acid may be prevalent among people living on high protein rations, diabetes and renal disorders are yet more dangerous to people of dietary habits like those of the Bengali, and that the large carbohydrate intake rendered necessary by a diet poor in nitrogen is even more likely to lead to injury and damage to the delicate tissues of glandular and other organs, and to a diminution in the resisting power of the system, than any excessive nitrogenous intake.

Other experiments recently made in Italy by P. Albertoni and F. Rossi[b] lead to similar conclusions but by a different method. The

[a] Standards of the Constituents of the Urine and Blood and the Bearing of the Metabolism of Bengalis on the Problems of Nutrition. D. McCay, Sci. Mem. Med. and Sanit. Depts. India, n. ser., 1908, No. 34, pp. 67.

[b] The Effect of Adding Meat to a Vegetarian Diet. Arch. Expt. Path. u. Pharmakol. 1908, Sup., pp. 29-38.

diet of typical peasants of the Abruzzi (among the least progressive of Italy), consisting mainly of corn meal (polenta), was carefully studied and various physical statistics of the subjects gathered during a given period. Considerable quantities of meat and other nitrogenous foods were then added to the diet for some weeks, with the result that the general physical and mental condition of the subjects was notably improved, so the authors state. The duration of these experiments was not sufficient to warrant positive deductions, but as far as they go they indicate that to increase the protein in a diet habitually poor in that nutrient improves the general condition of the subject. All such work is especially suggestive in the consideration of such problems as those presented by the present studies among the mountaineers, and the need for continued investigations before all the important questions regarding dietary standards and the relation of such standards to physiological requirements can be answered.

But whatever the standards, it is not always easy to apply them justly to the results of dietary studies. In order to get results typical of any locality, the studies must be carried on in families or other groups made up of individuals whose occupations, age, size, etc., vary considerably, and it is difficult to say with which standard of muscular activity the habits of the group correspond, or what factors should be used to reduce the diets of the women and children to a common "per-man-per-day" basis. In one or two studies of the present series, for instance, the children were so heavy that if the factors ordinarily used for children of their weights had been applied, almost all the food would have gone to their account and there would have been little left for the adults. Since the same factors are used in most American studies, the average results of different series are comparable among themselves, and the more studies are included in an average, the more, it is commonly said, do possible errors tend to neutralize each other.

On the whole, these dietaries represent as much energy as is usual but rather smaller amounts of protein than those indicated by the standards as desirable for persons of corresponding occupations, though the range in protein consumption is great and some of the families had rather high quantities. It is probable, nevertheless, that these dietaries are typical of the people among whom they were made, not only at the present time, but for several generations, possibly since the disappearance of the game which their ancestors, the early settlers, killed and ate in abundance. All precautions were taken to insure accuracy, but it is, of course, possible that in some instances foods not recorded were eaten or that some wild berries and fruits not mentioned in the tables were eaten between meals by the families studied, but the quantities can not have been large enough to

affect the general conclusions. However that may be, the food appeared to be fairly satisfying to the people; enough so, at any rate, for families who might have afforded better not to care to take the trouble to procure it.

The people of whom these families are typical are in that region considered fairly strong and well developed physically. Very few cases of illness were reported in these studies, many old persons were apparently capable of considerable active work, the weights of the adults averaged fairly high and can not be said to indicate underdevelopment, while the children appear to be certainly as heavy as is usual at their respective ages. On the other hand, visitors are almost invariably struck by the quickness with which these mountaineers, especially the women, lose the appearance of youth; judged by ordinary standards, girls of 22 or 23 would be called 30 or more, while women of 40 look as old as those of 55 or 60. Tuberculosis is common and the rate of mortality is rather high. While there are many individual exceptions, the general impression, confirmed by observations made in connection with these studies, is that these mountaineers are not active or energetic, either physically or mentally, as compared with the bulk of our rural population, and are rather generally lacking in ambition and progressiveness. It would be most interesting if investigations similar to the Italian ones referred to could be made in these regions, and the effect of a fuller diet noted.

WASTE.

The amount and nutritive value of the waste in these studies is summarized in the following table:

Nutrients and energy wasted in dietary studies of families in Tennessee.

[Quantities per man per day.]

Dietary study.	Protein.	Fat.	Carbohydrates.	Energy.
STUDIES NEAR TOWNS.	*Grams.*	*Grams.*	*Grams.*	*Calories.*
No. 604	3	3	19	115
No. 605	....	....	....	....
No. 606	2	1	15	77
No. 607	1	1	8	45
No. 608	1	1	9	49
No. 609	2	1	12	65
No. 610	1	1	10	53
No. 611	3	2	16	94
No. 612	1	2	7	50
No. 613	1	1	8	45
No. 614	3	2	17	98
No. 615	1	....	3	16
No. 616	2	1	9	53
No. 617	1	1	8	45
No. 618	5	3	29	162
No. 619	1	1	9	49
No. 620	1	1	13	65
No. 621	3	1	21	105
No. 622	1	1	15	73
No. 623	2	1	17	85
No. 624	1	....	6	28
No. 625	2	1	20	97

Nutrients and energy wasted in dietary studies of families in Tennessee—Continued.

Dietary study.	Protein.	Fat.	Carbohydrates.	Energy.
STUDIES NEAR TOWNS—continued.	*Grams.*	*Grams.*	*Grams.*	*Calories.*
No. 626 [a]	4	2	34	170
No. 627	1	1	16	77
No. 628	1		10	44
No. 629	3	1	23	113
No. 630	4	1	22	113
No. 631	1		5	24
No. 632	3	1	19	97
No. 633			2	8
No. 634	1	1	8	45
No. 635	1	1	8	45
No. 636			1	4
No. 637	1		6	28
No. 638			2	8
No. 639	3	3	17	107
No. 640			1	4
No. 641			2	8
No. 642	1	1	6	37
No. 643	1	1	7	41
No. 644	1	1	7	41
No. 645	2	2	13	78
No. 646			3	12
No. 647	1	1	8	45
No. 648	1	1	8	45
Average of 44 studies	2	1	10	54
STUDIES IN REMOTE DISTRICTS.				
No. 649			2	8
No. 650			1	4
No. 651			1	4
No. 652			3	12
No. 653				
No. 654			1	4
No. 655			1	4
No. 656			2	8
No. 657			2	8
No. 658				
No. 659				
No. 660				
No. 661			1	4
No. 662			1	4
No. 663				
No. 664				
No. 665				
No. 666			3	12
No. 667			3	12
Average of 19 studies			1	4
Average of 63 studies	([b])	([b])	7	40
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Proportion of total food purchases, 44 studies	2	([b])	([b])	2
Proportion of total food purchases, 19 studies			([b])	([b])
Proportion of total food purchases, 63 studies	1	([b])	([b])	1

[a] Not included in the average (see p. 104.)   [b] Less than 0.5 per cent.

The small proportion of waste is due in part to the fact that many of these families were obliged to economize closely, and in part to the simplicity of the diets, which made it easy to estimate how much would be eaten at each meal and also to use up what was left over from one meal at a later one.

Throughout the series the waste came mainly from the carbohydrates, not because they were less thoroughly eaten, but because they were more abundant than the protein and fat. The amounts of protein and fat wasted are so small as to be practically negligible. In many cases the amount of nutrients in the waste was too small

to be calculated, especially in the studies in remote districts, where the diet was even simpler than in the others.

The proportions of the total nutrients of the food purchased which are found in the waste are given at the foot of the table on page 115. The proportions of fats and carbohydrates were throughout less than one-half of 1 per cent. In the village studies 2 per cent each of the protein and energy were wasted. In the studies in remote districts no calculable protein or fat and less than one-half of 1 per cent of carbohydrates and total energy were discarded. The average for all the studies shows a waste of 1 per cent of both protein and energy.

In most low-priced, economical dietaries where the waste is believed to be small, it is not measured, and there is, therefore, little material with which to compare the present figures.

The waste was saved and analyzed in three of the New Mexican studies already referred to, and was much larger than in the Tennessee dietaries. The average was: Protein 4 per cent, fat 4 per cent, carbohydrates 2 per cent, and total fuel value 2 per cent. This difference is probably due to a less economical use and a greater variety of food materials.

In sixteen dietary studies made among poor families in New York City,[a] in which it was collected, the waste contained on the average 2 per cent each of the protein and fat of the food purchased, 1 per cent of the carbohydrates, and 2 per cent of the total energy. The average cost in these studies was 20 cents per man per day, and they showed a much greater variety of food materials than the Tennessee dietaries here reported. Considering the greater variety of the diets, the New York studies represent as frugal a use of the materials as the present ones, nor is the proportion of waste much greater than in the village Tennessee studies. In American families in more comfortable circumstances, and often among others of limited means, the waste is ordinarily much larger, amounting sometimes to 10 per cent or more of the nutrients[b] purchased. Compared with the ordinary dietaries of this country, therefore, the waste in the present studies is extremely small.

---

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 46.

[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 21, p. 219.

DIETARY STUDIES IN GEORGIA.

By H. C. White, Ph. D.,
Professor of Chemistry, University of Georgia.

INTRODUCTION.

The fourteen studies described in the following pages were conducted at the University of Georgia as a part of the nutrition investigations organized by the Office of Experiment Stations of the United States Department of Agriculture.

Dietary study No. 668 was made with a student's boarding club at the University of Georgia; No. 669 was conducted in the family of a mechanic living in Athens, Ga.; No. 670 was made in a negro family living near Athens, Ga.; while the eleven remaining studies were made with families in the mountain districts in White, Rabun, and Habersham counties. Four types of people are therefore included in these studies: (1) College students; (2) a white family in comfortable circumstances; (3) a negro family; and (4) mountaineers. The studies should be of interest, the first three because they give additional knowledge of the food consumption of their respective types, the remainder both as giving information on the food of mountaineers and also for comparison with the Tennessee mountaineer studies, tabulated and discussed earlier in this bulletin.

METHODS OF STUDY.

The customary methods of making dietary studies were followed in this series. At the beginning of the investigation all foodstuffs on hand were weighed and their cost noted, as was also done with all foodstuffs purchased during the investigation. As a precaution against error, all refuse and waste matters on the premises when the experiment began were disposed of. At the close of the investigation the weights and cost of all food on hand were deducted from the totals thus obtained.

From the data thus obtained the results of the study were calculated according to the usual methods, these results being tabulated in the tables beyond. A considerable number of analyses of foods and waste material were made in connection with the studies.

In determining the composition of the foodstuffs, where the quantity used was large or the material such as presents wide variations from an average, samples were taken from either the material actually

used or similar material purchased in the local market. For example, the flour, meal, crackers, sirup, grits, baked beans, cowpeas, ham, salt pork, dried apples, fish, poultry, cheese, and butterine used in study No. 668 were sampled for analysis from the materials actually used. The beef (steak and roast) analyzed was from samples of similar cuts of animals raised in the neighborhood and slaughtered in Athens. In cases where wild game (squirrel and birds) formed part of the dietary, similar animals were secured and analyzed. The composition of the milk, buttermilk, and potatoes used was assumed from a number of analyses previously made in the laboratory in connection with other investigations.

The methods employed in the analyses of food and waste were those recommended by the Association of Official Agricultural Chemists.[a] The chemical composition of all foods analyzed in connection with this and the following thirteen studies are summarized in the table below.

The composition of the foodstuffs not analyzed was assumed from data reported in a previous bulletin[b] of this Office.

The figures in parenthesis which follow each food in the tabular statement of the results of the dietary studies indicate the data used in calculating the nutrients and energy which the food supplies, Nos. 1 to 76 referring to the average values reported in the table below, and the remaining numbers to data summarized in a manuscript table on file in the Office of Experiment Stations.

Percentage composition of food materials analyzed in connection with dietary studies Nos. 668–681.

Reference No.	Kind of food.	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.
	ANIMAL FOOD.						
	Beef:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*
1	Rib roast	21.64	54.13	15.35	8.22	....	0.91
2	Steak, round	14.12	56.59	18.43	9.62	....	1.48
	Pork:						
3	Bacon		12.8	8.1	72.9	....	6.2
4	Do		11.8	8.3	74.1	....	5.8
5	Do		6.9	7.6	80.1	....	5.4
6	Do		12.5	9.0	72.4	....	6.1
7	Do		11.9	9.5	73.1	....	5.5
8	Do		12.2	10.1	71.9	....	5.8
9	Do		11.6	8.7	74.1	....	5.6
10	Do		12.5	9.2	73.0	....	5.3
11	Do		13.2	8.2	73.2	....	5.4
12	Do		12.4	7.3	74.2	....	6.1
13	Do		13.5	6.9	73.2	....	6.4
14	Do		11.8	8.8	74.2	....	5.2
15	Ham, dried	8.24	37.82	24.16	22.78	....	4.71
16	Ham, cured	13.64	33.83	15.22	32.56	....	4.91
17	Side, salt	....	12.48	2.36	82.51	....	3.14
	Game:						
18	Quail, American dressed	32.6	42.0	14.2	10.4	....	.8
19	Squirrel, dressed	31.4	41.6	14.5	11.2	....	1.3

[a] U. S. Dept. Agr., Bur. Chem. Bul. 65.

[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 28.

Percentage composition of food materials analyzed in connection with dietary studies Nos. 668-681—Continued.

Reference No.	Kind of food.	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.
	ANIMAL FOOD—continued.						
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*
20	Fish, fresh, dressed (locally called "trout" but similar to weakfish)	20.24	59.97	16.63	2.46	....	0.98
21	Poultry: Fowls, dressed	18.56	43.57	20.54	16.19	....	1.22
22	Cheese	....	33.46	26.37	34.74	1.62	3.81
23	Butter	....	13.2	.9	81.8	....	4.1
24	Do	....	12.6	1.0	82.8	....	3.6
25	Milk	....	87.52	3.15	4.04	4.62	.67
26	Do	....	87.9	3.2	3.5	4.6	.8
27	Do	....	88.3	3.0	3.8	4.0	.9
28	Do	....	87.2	3.4	3.7	4.9	.8
29	Buttermilk	....	92.82	2.98	.51	3.00	6.9
30	Do	....	90.9	2.8	.8	4.6	.9
31	Do	....	91.9	2.6	.6	4.1	.8
	VEGETABLE FOOD.						
	Cereals:						
32	Corn meal	....	11.86	7.34	55.18	74.43	1.19
33	Do	....	14.7	8.0	4.1	71.8	1.4
34	Do	....	13.8	8.2	3.9	72.6	1.5
35	Do	....	12.3	8.4	3.8	74.1	1.4
36	Do	....	13.6	8.2	4.3	72.4	1.5
37	Do	....	13.5	8.1	4.2	72.8	1.4
38	Do	....	13.2	8.4	3.9	73.2	1.3
39	Do	....	14.1	7.8	4.2	72.4	1.5
40	Do	....	14.2	8.0	4.5	71.9	1.4
41	Do	....	13.5	7.7	4.3	73.1	1.4
42	Average of Nos. 39-41	....	....	7.8	4.3	72.5	....
43	Grits	....	10.34	9.61	1.02	78.37	.66
44	Flour, wheat, fine	....	12.04	11.18	1.42	74.78	.58
45	Flour, wheat, family	....	11.07	11.81	1.22	75.44	.46
46	Flour, wheat	....	8.9	10.8	1.2	77.8	1.3
47	Do	....	8.9	10.8	1.2	77.8	1.3
48	Do	....	9.2	11.1	1.3	77.2	1.2
49	Do	....	8.8	10.6	1.2	78.0	1.4
50	Do	....	8.9	11.1	1.1	77.5	1.4
51	Do	....	8.8	10.8	1.2	78.0	1.2
52	Do	....	8.0	11.0	1.3	78.2	1.5
53	Crackers, soda	....	5.79	10.48	10.13	71.32	2.28
54	Lady fingers	....	6.19	7.33	8.64	76.45	1.39
	Sugars, etc.:						
55	Sirup	....	25.34	1.85	....	72.53	.28
56	Do	....	14.7	....	....	79.1	6.2
57	Do	....	13.7	....	....	80.4	5.9
58	Do	....	17.1	....	....	75.8	7.1
59	Do	....	12.2	....	....	82.0	5.8
60	Do	....	15.0	....	....	78.6	6.4
61	Do	....	11.7	....	....	81.5	6.8
	Vegetables, etc.:						
62	Beans, baked	....	68.98	7.04	2.29	18.81	2.88
63	Cabbage	13.1	79.9	1.2	.1	4.6	1.1
64	Cowpeas	....	11.94	21.80	2.17	63.18	.91
65	Do	....	10.8	22.6	1.2	62.1	3.3
66	Onions	6.8	80.8	1.6	.2	9.8	.8
67	Potatoes, white	20.00	61.24	1.95	....	16.14	.67
68	Do	21.2	60.8	1.7	.1	15.2	1.0
69	Turnips	16.4	76.9	1.0	.1	4.7	.9
70	Turnip salad, greens	....	86.34	4.22	.58	6.26	2.60
	Fruits:						
71	Apples, evaporated	....	35.18	1.48	2.37	58.81	2.16
72	Apples, sun dried	....	33.34	2.12	2.56	60.02	1.96
73	Apples, dried	....	13.1	2.0	2.0	80.4	2.5
74	Do	....	12.3	2.1	2.6	80.2	2.8
75	Average of Nos. 73 and 74	....	....	2.1	2.3	80.3	....
76	Miscellaneous: Butterine	....	8.00	.78	87.96	....	3.36

All the studies were conducted in the same manner, with the exception that the data concerning waste varied somewhat in the different studies. In study No. 668 the refuse and waste were collected each day, separate receptacles being used for "meat," "bread," and "vegetable" wastes. This classification of the waste was maintained as accurately as possible, but was, of course, only approximate in some cases. Each lot of waste was weighed and sampled carefully, and chemical analyses were made of the water-free material. In all, analyses were made of 83 samples of waste stuffs, there being seven days of the thirty on which no "vegetable" waste was separately collected.

In study No. 669 two analyses of waste, one of the animal and one of the vegetable, were made daily. The individual analyses of waste in these two studies, being of no value outside this study, are not reported. In the remaining studies the total water-free waste material was analyzed. The table below shows the proportion of nutrients in the wastes of the several studies. It must be understood, however, that the figures given in this table for waste from studies Nos. 668 and 669 are only approximations. The individual analyses of waste for these studies were not reported, nor were the average figures. The data of the table are computed by dividing the total water-free material of the waste of each class by the amount of the different nutrients reported as contained in it.

The table below shows the nutritive matter in the samples of waste food which were analyzed in connection with the dietary studies:

Proportion of nutrients in water-free substance of wastes, dietary studies Nos. 668–681.

Reference No.		Protein.	Fat.	Carbohydrates.
		Per cent.	*Per cent.*	*Per cent.*
114	Meat waste, study No. 668[a]	11.9	3.4	0.2
115	Bread waste, study No. 668[a]	4.5	1.0	47.6
116	Vegetable waste, study No. 668[a]	2.9	.6	16.3
117	Animal waste, study No. 669[a]	5.6	27.6	....
118	Vegetable waste, study No. 669[a]	2.0	.3	14.6
119	Waste, study No. 671	9.7	10.2	69.5
120	Waste, study No. 672	11.6	11.8	72.6
121	Waste, study No. 670	8.8	12.2	73.8
122	Waste, study No. 673	9.6	12.5	73.7
123	Waste, study No. 674	10.2	13.6	71.1
124	Waste, study No. 675	10.5	9.8	74.6
125	Waste, study No. 676	7.6	12.3	74.6
126	Waste, study No. 677	8.6	12.1	73.5
127	Waste, study No. 678	7.2	10.4	77.8
128	Waste, study No. 679	5.6	9.2	80.7
129	Waste, study No. 680	6.1	7.1	82.6
130	Waste, study No. 681	7.2	8.4	80.3

[a] Calculated, see above.

DIETARY STUDY OF A STUDENTS' BOARDING CLUB, STUDY No. 668.

This club is composed of men students of the University of Georgia, and was organized for the purpose of securing board cheaply. It is a voluntary organization, and at the time the study was made had been in existence three years. The number of members varies from time to time; the average for the session of 1901–2 was approximately 100. The club is under student management, the members appointing a committee of their number to have the general oversight of its affairs. The university furnishes, free of cost, an excellently appointed building (Denmark Hall) containing dining rooms, kitchen, pantries, furniture, fixtures, and table and kitchen ware. All other expenses, for food, fuel, light, service, etc., are met by the club. A professor of the university acts gratuitously for the club as manager and purchasing agent. A matron is employed by the club, receiving a salary of $25 per month with her board and lodging. Colored men are employed as waiters and colored men and women for kitchen service, and their meals are included with those of the members in this study. Each member of the club pays, in advance, $8 at the beginning of each month. Accurate account is kept of the expenditures, and at the end of the collegiate session any excess of receipts over expenditures is equitably distributed among the members. Since the organization of the club there has been no loss from failure of members to make their payments, and the average monthly expense per man has at no time exceeded $8 and has generally been somewhat less.

The study began with dinner on May 1, 1902, and continued thirty days, a longer period than is ordinarily covered by such investigations. However, it is believed that the study is all the more valuable, since it covers so long a period.

NUMBER OF MEALS EATEN.

The average age and weight of the subjects of the study, and the number of meals eaten, reduced to the usual per man per day basis, are given below:

	Meals.
Number of men, 102 to 109; average age, 21 years; average weight, 143 pounds; meals eaten—breakfasts, 2,961; dinners, 3,192; suppers, 3,074. Total	9,227
Number of women, 4; meals eaten—breakfasts, 113; dinners, 114; suppers, 112. Total (339×0.8 meal of man), equivalent to	271
Total number of meals equivalent to	9,498
Equivalent to 1 man for 3,166 days.	

Weights and cost of food and nutrients in dietary study No. 668.

Food consumed during the entire study (30 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Beef: Brisket, 20.3 pounds, $1.60 (77); rib, roast, 342.5 pounds, $42.81 (1); steak, round, 810.2 pounds, $101.25 (2); corned, 1.9 pounds, 22 cents (78); Veal: Loin, 85.6 pounds, $10.63 (79); Lamb: Leg, 45.5 pounds, $5.69 (80)	*Dollars.* 162.20	*Cents.* 5.1	*Grams.* 33	*Grams.* 18	*Grams.*	*Calories.* 292
Pork: Side, fresh, 39.6 pounds, $4.93 (82); ham, dried, 12.1 pounds, $1.32 (15); ham, cured, 505.1 pounds, $70.70 (16); side, salt, 72.3 pounds, $7.77 (17); lard, 367.5 pounds, $39.51 (83)	124.23	3.9	12	88		831
Poultry: Fowls, 249.4 pounds, $12.45 (21)	12.45	.4	7	6		81
Fish, fresh, 48.6 pounds, $4.42 (20)	4.42	.1	1			4
Eggs, 86.7 pounds, $14.83 (85)	14.83	.5	2	1		17
Butter, 146.3 pounds, $21.94 (86)	21.94	.7		18		160
Cheese, 48.2 pounds, $6.72 (22)	6.72	.2	2	3		35
Milk, 2,231 pounds, $27.80 (25); buttermilk, 708.5 pounds, $5.35 (29)	33.15	1.1	13	13	18	240
Total animal food	379.94	12.0	70	147	18	1,660
VEGETABLE FOOD.						
Cereals: Corn meal, 332.2 pounds, $6.64 (32); grits, 152.3 pounds, $3.81 (43); oatmeal, 88.4 pounds, $2.65 (88); rice, 124.1 pounds, $6.20 (89); wheat flour, graham, 176.3 pounds, $3.82 (90); wheat flour, family, 183.1 pounds, $3.43 (45); wheat flour, fine, 1,665.2 pounds, $36 (44); macaroni, 32 pounds, $2.72 (91); soda crackers, 75.2 pounds, $3.76 (53); lady fingers, 8 pounds, $1.60 (54)	70.63	2.2	44	9	303	1,468
Sugars, etc.: Sirup, 224 pounds, $6.72 (55); sugar, brown, 217.4 pounds, $10.33 (93); sugar, granulated, 697.2 pounds, $40.09 (94)	57.14	1.8	1		153	616
Vegetables: Beans, baked, 11.5 pounds, 69 cents (62); beans, string, 116.5 pounds, $3.15 (95); beets, 15.8 pounds, 26 cents (96); cabbage, 114.5 pounds, $2.86 (97); corn, canned, 53.6 pounds, $2.15 (98); lettuce, 11.3 pounds, 55 cents (99); okra and tomatoes, canned, 91.5 pounds, $4.80 (100); onions, 70.2 pounds, $1.36 (101); peas, green, 107.6 pounds, $2.85 (102); cowpeas, 24.8 pounds, 83 cents (64); potatoes, 197.5 pounds, $2.96 (67); radishes, 7.5 pounds, 24 cents (106); squash, 8.3 pounds, 52 cents (107); turnip salad greens, 136.3 pounds, $5.25 (70); pickles, cucumber, 24.5 pounds, $1.20 (103)	29.67	.9	5	1	16	93
Fruits: Apples, evaporated, 43.4 pounds, $2.17 (71); apples, sun dried, 32.2 pounds, $1.61 (72); lemons, 37.5 pounds, $1.89 (110); peaches, canned, 32.4 pounds, $2.92 (111); pineapples, canned, 26.5 pounds, $1.06 (112); strawberries, 36.5 pounds, $1.80 (113)	11.45	.4			9	36
Butterine,[a] 39.8 pounds, $5.45 (76)	5.45	.2		5		45
Total vegetable food	174.34	5.5	50	15	481	2,258
Total food purchased	554.28	17.5	120	162	499	3,918
WASTE.						
Animal food (114)			4	12	1	127
Vegetable food (115) and (116)			7	1	64	293
Total food wasted			11	13	65	420
FOOD EATEN.						
Animal food			66	135	17	1,533
Vegetable food			43	14	417	1,965
Total food eaten	554.28	[b]17.8	109	149	434	3,498

[a] Composed mainly of cotton-seed oil, hence classed with vegetable foods.
[b] Including 0.3 cent per man per day for beverages, condiments, etc.

From the table (p. 122) it will be seen that the average amount of food consumed per man per day yielded 109 grams of protein and 3,498 calories of energy, at a cost of 17.8 cents. The amount of food actually furnished was about 10 per cent greater in both protein and energy. The amount of protein consumed seems surprisingly small when it is considered that the subjects were probably all young men, nearly all of whom were in robust health, and, moreover, that they had not yet reached their fullest physical development. The amount of energy consumed would indicate that their muscular activity was considerable, being very close to that of the American standard for a man at moderate muscular work.

Results similar to the above, in which the protein is low and the energy high, thereby giving a rather wide nutritive ratio, have repeatedly been found with studies made in the Southern States. For example, in dietary studies with Tennessee families, similar wide ratios were found, the exact figures for food eaten being 84 grams of protein and 3,674 calories of energy per man per day. On the other hand, a comparison with other studies made with students' boarding clubs shows the results here found to be for all practical purposes identical with the average of sixteen studies previously reported by this Office. Yet these sixteen studies are divided about equally between students' clubs North and South. The indications are that such young men demand an amount of energy approaching that consumed by men at moderately active muscular work, but that their protein requirements are much lower, even though they have not yet arrived at the age of full physical development.

It is felt that no proper comparison can be made of the cost of the food of this club with that for other clubs, inasmuch as the prices of food supplies have been increased so much and vary so much in different localities during the last few years. The cost was at least reasonable and moderate, and the club would seem to have thoroughly fulfilled its purpose.

DIETARY STUDY OF A MECHANIC'S FAMILY, STUDY No. 669.

In the prosecution of this study the cooperation was secured of a family of imperfectly skilled mechanics, quite typical of a somewhat numerous class of white people in this section. The family comprised a man and his wife, a son and his wife, a younger unmarried son, and an infant of 2 years. The men were all carpenters, sober, industrious, and hard-working, receiving wages varying from \$1.25 to \$2 per day. The cooking and household work of the family were done by the women. All members of the family were in robust health. The foodstuffs used were assumed to have the composition of similar articles in the study of the college club previously reported.

This study began May 15, 1902, and continued fourteen days. The ages and weights of the members of the family, and the number of meals taken, were as follows.

	Meals.
Man, age 45 years, weight 160 pounds; Man, age 23 years, weight 150 pounds; Man, age 20 years, weight 141 pounds	124.0
Woman, age 43 years, weight 150 pounds; woman, age 20 years, weight 110 pounds (80 meals × 0.8 meal of man), equivalent to..	64.0
Infant, age 2 years, (42 meals × 0.3 meal of man), equivalent to..	12.6
Total number of meals equivalent to	200.6

Equivalent to 1 man for 67 days.

Weights and cost of food and nutrients in dietary study No. 669.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef: Rib roast, 10.3 pounds, $1.25 (1); round steak, 4.2 pounds, 55 cents (2). Lamb: Leg, 5.4 pounds, 70 cents (80)	2.50	3.7	22	16	....	230
Pork: Ham, fresh, 17.6 pounds, $2.20 (81); side, salt, 20.5 pounds, $2.05 (17); lard, 8.1 pounds, 81 cents (83)	5.06	7.6	20	205	....	1,901
Fish, fresh, 4.5 pounds, 40 cents (20)	.40	.6	5	1	....	29
Eggs, 4.8 pounds, 80 cents (85)	.80	1.2	5	3	....	47
Butter, 2 pounds, 40 cents (86)	.40	.6	....	11	....	98
Cheese, 1.2 pounds, 15 cents (22)	.15	.2	2	3	....	35
Milk, 16.3 pounds, 35 cents (25); buttermilk, 29.6 pounds, 30 cents (29)	.65	1.0	10	5	11	128
Total animal food	9.96	14.9	64	244	11	2,471
VEGETABLE FOOD.						
Cereals: Corn meal, 26.2 pounds, 52 cents (32); rice, 4.1 pounds, 33 cents (89); flour, wheat, 40.5 pounds, 90 cents (41)	1.75	2.6	46	13	359	1,736
Sugars, etc.: Sugar, brown, 2.4 pounds, 10 cents (93); sirup, 9 pounds, 35 cents (55)	.45	.7	1	....	60	244
Vegetables: Cabbage, 3.2 pounds, 8 cents (97); cowpeas, 5.1 pounds, 17 cents (64); potatoes, 16.2 pounds, 25 cents (67); turnip salad greens, 10.1 pounds, 40 cents (70)	.90	1.3	13	1	45	241
Fruits: Apples, evaporated, 4.5 pounds, 22 cents (71); peaches, canned, 4 pounds, 32 cents (111)	.54	.8	1	1	21	97
Total vegetable food	3.64	5.4	61	15	485	2,318
Total food purchased	13.60	20.3	125	259	496	4,789
WASTE.						
Animal food (117)			2	11	....	106
Vegetable food (118)			5	1	41	193
Total food			7	12	41	299
Animal food eaten			62	233	11	2,365
Vegetable food eaten			56	14	444	2,125
Total food eaten	13.60	20.3	118	247	455	4,490

From the figures given above it appears that the diet of this family yielded a generous amount of energy and probably sufficient protein for their needs. It was fairly varied, nearly all classes of foods being represented. Its cost is moderate. Like most southern dietaries, it yields a higher fuel value in proportion to the protein than corresponding ones in the North, a difference due mainly to a greater consumption of pork and corn meal in the South, and less of the leaner meats and other less fatty cereals.

DIETARY STUDY OF A NEGRO FARMER'S FAMILY, STUDY No. 670.

This study was made in a family of negro farm laborers in Clark County, Ga. This family is typical of the farm laborers of this section, which is not in the "black belt," and in which the negroes are generally more thrifty, intelligent, and better housed and fed than in the "low country," where the black population is largely in excess of the white. The family consisted of a man and his wife, two unmarried sons, and a daughter. The men were engaged exclusively in farm labor, tilling a small patch of land of which the father was the owner, and adjacent lands which were rented, payment of rent being made on "shares." The farm products were cotton, corn, and hay. Vegetables were grown for home consumption in a garden patch. The wife took care of the house; the girl assisted her, but also attended school a portion of the year. Of the food consumed, the meal, flour, sugar, and sirup were purchased in town; the bacon and vegetables were home raised.

The study began with breakfast September 16, 1902, and continued fourteen days. The ages and weights of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 46 years, weight 160 pounds Man, age 22 years, weight 148 pounds Boy, age 17 years, weight 130 pounds	121
Woman, age 42 years, weight 150 pounds; girl, age 15 years, weight 115 pounds (80 meals × 0.8 meal of man), equivalent to	64
Total number of meals equivalent to	185

Equivalent to 1 man for 62 days.

Weights and cost of food and nutrients in dietary study No. 670.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Bacon, 18,950 grams, $6.40 (5); lard, 3,115 grams, 75 cents (83)	*Dollars.* 7.15	*Cents.* 11.5	*Grams.* 23	*Grams.* 295	*Grams.*	*Calories.* 2,718
Total animal food	7.15	11.5	23	295	....	2,718
VEGETABLE FOOD.						
Cereals: Corn meal, 26,000 grams, $1.15 (35); flour, 4,105 grams, 24 cents (48)	1.39	2.2	42	17	362	1,767
Sugars, etc.: Sirup, 3,200 grams, 23 cents (92); sugar, granulated, 1,140 grams, 12 cents (94)	.35	.6	....	....	54	216
Vegetables: Beans, string, 3,142 grams, 15 cents (95); sweet potatoes, 1,921 grams, 30 cents (104); turnip salad greens, 4,678 grams, 24 cents (70)	.69	1.1	5	1	15	89
Total vegetable food	2.43	3.9	47	18	431	2,072
Total food purchased	9.58	15.4	70	313	431	4,790
Waste, animal and vegetable (121)	....	....	14	19	115	685
Total food eaten	9.58	15.4	56	294	316	4,105

The main features of this diet are fat, cured pork, and corn meal, characteristic of both the "black belt" and the mountain regions of the South. It is superior to the dietaries studied among Alabama negroes,[a] in containing a considerable number of vegetables and some wheat flour and sugar. Compared with the negro studies referred to and those among mountaineers reported elsewhere in this bulletin, the cost is fairly high, especially considering the amount of protein supplied. The latter is 70 grams per man per day, but as the waste in this study is somewhat large—containing one-fifth of the protein and about one-seventh of the fuel value—the amount actually consumed was only 56 grams. This is only half the quantity called for by the dietary standard for a man at moderate muscular work. The energy, on the other hand, is higher than the standard calls for. No dairy products were used by this family during the study, although they were living in a region with fair grazing lands. If such cheap articles as buttermilk and skim milk were as easily available as one would suppose, the addition of them to the diet would bring up the amount of protein supplied without greatly increasing the cost.

STUDIES WITH GEORGIA MOUNTAINEERS, Nos. 671–681.

The eleven studies which follow were conducted in the families of mountaineers living in the recesses of the mountains in northeastern Georgia. They were good examples of the mountain peoples of the Southern States. One or two of the families were of rather better class, owning some land. The majority were "renters," typical of the so-called "poor whites" of this section. The men were engaged chiefly in farm work, growing corn, potatoes, and apples. They also found occupation for a part of the time in wood cutting and bark collecting. The women attended to the housework, cooking, etc., and helped in the work of the farm and garden. Most of them occupied three-room log cabins of the usual mountain type. The bacon, vegetables, and dried apples used were home raised; the meal, flour, and sugar purchased at the country store. It was found difficult, under the circumstances, to assign a proper money value (cost) to the materials used, but prevailing prices at the country stores were taken as approximately fair. Probably the prices charged were higher than in towns, where there is competition among dealers.

The exact dates of the last six studies were not reported, but they were made in the early months of 1903.

Owing to the general similarity of these studies, they are discussed together instead of individually. (See p. 135.)

---

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 38.

DIETARY STUDY No. 671.

This family consisted of the father, mother, son, and five daughters. It is typical of the poorer classes of white people inhabiting the mountainous region of this section. The father is a small farmer, tilling patches of his own land with the assistance of the older members of the family; the mother and younger girls keep house. The principal produce is corn and apples. The former is sold in the neighborhood, the latter frequently carried by wagon a number of miles to town. The food of the family is mainly corn meal obtained from local mills, flour purchased at the nearest country store, and native bacon, most generally of home production.

The study began September 1, 1902, and was continued fourteen days. The ages and weights of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 43 years, weight 125 pounds	42.0
Woman, age 42 years, weight 110 pounds (42 meals × 0.8 meal of man), equivalent to	33.6
Woman, age 21 years, weight 140 pounds (42 meals × 0.8 meal of man), equivalent to	33.6
Woman, age 16 years, weight 90 pounds (42 meals × 0.8 meal of man), equivalent to	33.6
Girl, age 12 years, weight 70 pounds (42 meals × 0.6 meal of man), equivalent to	25.2
Girl, age 8 years, weight 32 pounds (42 meals × 0.5 meal of man), equivalent to	21.0
Girl, age 6 years, weight 30 pounds (42 meals × 0.5 meal of man), equivalent to	21.0
Boy, age 10 years, weight 50 pounds (42 meals × 0.8 meal of man), equivalent to	25.2
Total number of meals equivalent to	235.2

Equivalent to 1 man for 78 days.

Weights and cost of food and nutrients in dietary study No. 671.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Bacon, 6,346 grams, $2.08 (3); lard, 4,550 grams, $1.32 (83)	*Dollars.* 3.40	*Cents.* 4.3	*Grams.* 7	*Grams.* 118	*Grams.*	*Calories.* 1,078
Total animal food	3.40	4.3	7	118	....	1,078
VEGETABLE FOOD.						
Cereals: Corn meal, 22,230 grams, $1 (33); flour, wheat, 31,120 grams, $1.72 (46)	2.72	3.5	66	17	515	2,475
Sugars: Sugar, granulated, 3,630 grams, 48 cents (94)	.48	.6	....	....	46	184
Vegetables: Beans, string, 27,240 grams, $1.18 (95); cabbage, 11,020 grams, 30 cents (97); potatoes, 54,490 grams, $1.62 (105)	3.10	4.0	22	2	134	642
Fruits: Apples, 36,510 grams, $1 (108)	1.00	1.3	1	1	51	217
Total vegetable food	7.30	9.4	89	20	746	3,518
Total food purchased	10.70	13.7	96	138	746	4,596
Waste, animal and vegetable (119)	....	....	7	8	52	307
Total food eaten	10.70	13.7	89	130	694	4,289

DIETARY STUDY No. 672.

This study was carried on simultaneously with study No. 671. The family lived in one of the wildest and most isolated sections of this mountain region, and is typical of the average class of the poor mountaineer. It consisted of a man and his wife, a son and his wife, an unmarried son, and a granddaughter. The men tilled small patches of arable land, producing mainly corn, tobacco, and apples; they also worked at gathering bark for local tanneries some miles distant. The food used was similar to that described in study No. 671. The sirup, flour, and sugar used were purchased at the country store; the meal was locally ground; and the bacon, vegetables, and fruit were of home production.

The study began with breakfast September 1, 1902, and was continued fourteen days. The ages and weights of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 48 years, weight 142 pounds	42.0
Woman, age 47 years, weight 128 pounds (42 meals × 0.8 meal of man), equivalent to	33.6
Man, age 26 years, weight 140 pounds	42.0
Woman, age 25 years, weight 122 pounds (42 meals × 0.8 meal of man), equivalent to	33.6
Man, age 20 years, weight 130 pounds	42.0
Girl, age 6 years, weight 50 pounds (42 meals × 0.5 meal of man), equivalent to	21.0
Total number of meals equivalent to	214.2

Equivalent to 1 man for 71 days.

Weights and cost of food and nutrients in dietary study No. 672.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 7,520 grams, $2.43 (4); lard, 4,692 grams, $1.60 (83)	4.03	5.7	9	145	....	1,327
Total animal food	4.03	5.7	9	145	....	1,327
VEGETABLE FOOD.						
Cereals: Corn meal, 35,650 grams, $1.90 (34); flour, 18,241 grams, $1.10 (47)	3.00	4.2	69	23	565	2,740
Sugars, etc.: Sirup, 5,040 grams, 21 cents (92); sugar, granulated, 2,350 grams, 18 cents (94)	.39	.5	....	....	82	328
Vegetables: Beans, string, 21,642 grams, 92 cents (95); cabbage, 12,560 grams, 34 cents (97); potatoes, 63,425 grams, $1.76 (105)	3.02	4.3	25	2	161	762
Fruits: Apples, dried, 4,110 grams, 80 cents (109)	.80	1.1	1	1	38	165
Total vegetable food	7.21	10.1	95	26	846	3,995
Total food purchased	11.24	15.8	104	171	846	5,322
Waste, animal and vegetable (120)	....	....	10	10	63	381
Total food eaten	11.24	15.8	94	161	783	4,941

DIETARY STUDY No. 673.

The study began November 10, 1902, and continued fourteen days. The ages and weights of the several members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 52 years, weight 136 pounds; Man, age 20 years, weight 140 pounds	82.0
Woman, age 50 years, weight 130 pounds; girl, age 15 years, weight 110 pounds (81 meals × 0.8 meal of man), equivalent to	64.8
Girl, age 10 years, weight 90 pounds (40 meals × 0.6 meal of man), equivalent to	24.0
Boy, age 8 years, weight 80 pounds (40 meals × 0.5 meal of man), equivalent to	20.0
Total number of meals equivalent to	190.8

Equivalent to 1 man for 64 days.

Weights and cost of food and nutrients in dietary study No. 673.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 6,325 grams, $1.68 (6); lard, 3,560 grams, 78 cents (83)	2.46	3.8	9	127	....	1,166
Game: Squirrel, 725 grams, 18 cents (19)	.18	.3	2	1	....	17
Total animal food	2.64	4.1	11	128	....	1,183
VEGETABLE FOOD.						
Cereals: Corn meal, 40,550 grams, $1.62 (36); flour, 14,525 grams, 80 cents (49)	2.42	3.8	76	30	635	3,111
Sugars, etc.: Sirup, 5,620 grams, 25 cents (92); sugar, granulated, 1,860 grams, 20 cents (94)	.45	.7	....	....	90	360
Vegetables: Potatoes, 65,545 grams, $1.90 (105)	1.90	3.0	18	1	151	685
Fruits: Apples, dried, 5,230 grams, 78 cents (109)	.78	1.2	1	2	54	238
Total vegetable food	5.55	8.7	95	33	930	4,394
Total food purchased	8.19	12.8	106	161	930	5,577
Waste, animal and vegetable (122)	....	....	10	13	77	464
Total food eaten	8.19	12.8	96	148	853	5,113

DIETARY STUDY No. 674.

The study began November 12, 1902, and continued fourteen days. The ages and weights of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 54 years, weight 152 pounds; Man, age 18 years, weight 145 pounds	81.0
Woman, age 50 years, weight 148 pounds; woman, age 20 years, weight 132 pounds (82 meals × 0.8 meal of man), equivalent to	65.6
Boy, age 11 years, weight 88 pounds (40 meals × 0.6 meal of man), equivalent to	24.0
Girl, age 8 years, weight 75 pounds; girl, age 6 years, weight 70 pounds (82 meals × 0.5 meal of man), equivalent to	41.0
Total number of meals equivalent to	211.6

Equivalent to 1 man for 71 days.

Weights and cost of food and nutrients in dietary study No. 674.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 7,108 grams, $1.88 (7); lard, 3,612 grams, 79 cents (83)	2.67	3.8	9	124	....	1,139
Eggs, 542 grams, 18 cents (84)	.18	.2	1	1	....	13
Milk, 3,650 grams, 7 cents (87)	.07	.1	2	2	2	34
Total animal food	2.92	4.1	12	127	2	1,186
VEGETABLE FOOD.						
Cereals: Corn meal, 39,520 grams, $1.48 (37); flour, wheat, 38,650 grams, $2.13 (50)	3.61	5.1	106	29	827	3,990
Sugars, etc.: Sirup, 5,810 grams, 26 cents (92); sugar, granulated, 1,785 grams, 20 cents (94)	.46	.6	....	....	82	328
Vegetables: Cabbage, 1,062 grams, 3 cents (97); potatoes, white, 54,680 grams, $1.59 (105); potatoes, sweet, 14,590 grams, 44 cents (104); turnip salad greens, 4,125 grams, 13 cents (70)	2.19	3.1	19	2	163	746
Fruits: Apples, dried, 5,410 grams, 81 cents (109)	.81	1.2	1	2	50	222
Total vegetable food	7.07	10.0	126	33	1,122	5,286
Total food purchased	9.99	14.1	138	160	1,124	6,472
Waste, animal and vegetable (123)	....	....	11	15	81	502
Total food eaten	9.99	14.1	127	145	1,043	5,970

DIETARY STUDY No. 675.

The study began November 18, 1902, and continued fourteen days. The ages and weights of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 40 years, weight 141 pounds	42.0
Woman, age 37 years, weight 116 pounds (42 meals × 0.8 meal of man), equivalent to	33.6
Boy, age 8 years, weight 65 pounds; girl, age 6 years, weight 50 pounds (84 meals × 0.5 meal of man), equivalent to	42.0
Girl, age 4 years, weight 32 pounds (42 meals × 0.4 meal of man), equivalent to	16.8
Total number of meals equivalent to	134.4

Equivalent to 1 man for 45 days.

Weights and cost of food and nutrients in dietary study No. 675.

Food consumed during entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
	Dollars.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 4,615 grams, $1.23 (8); lard, 2,510 grams, 55 cents (83)	1.78	4.0	10	130	....	1,197
Game: Quail, 635 grams, 28 cents (18)	.28	.6	2	1	....	17
Eggs, 455 grams, 15 cents (84)	.15	.3	1	1	....	13
Milk, 2,090 grams, 4 cents (87)	.04	.1	2	2	2	34
Total animal food	2.25	5.0	15	134	2	1,261

Weights and cost of food and nutrients in dietary study No. 675—Continued.

Food consumed during the entire study (14 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
VEGETABLE FOOD.						
Cereals: Corn meal, 30,280 grams, $1.21 (38); flour, wheat, 18,405 grams, $1.01 (51)	*Dollars.* 2.22	*Cents.* 4.9	*Grams.* 101	*Grams.* 31	*Grams.* 812	*Calories.* 3,928
Sugars, etc.: Sugar, granulated, 1,610 grams, 18 cents (94)	.18	.4	....	....	36	144
Vegetables: Potatoes, white, 40,520 grams, $1.18 (105); potatoes, sweet, 10,125 grams, 31 cents (104); turnip salad greens, 2,500 grams, 8 cents (70)	1.57	3.5	22	3	185	854
Fruits: Apples, dried, 2,985 grams, 45 cents (109)	.45	1.0	1	1	44	189
Total vegetable food	4.42	9.8	124	35	1,077	5,115
Total food purchased	6.67	14.8	139	169	1,079	6,376
Waste, animal and vegetable (124)	....	....	12	11	85	486
Total food eaten	6.67	14.8	127	158	994	5,890

DIETARY STUDY No. 676.

This study lasted seven days. The ages of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 33 years	21.0
Woman, age 30 years (21 meals × 0.8 meal of man), equivalent to	16.8
Boy, age 10 years (21 meals × 0.6 meal of man), equivalent to	12.6
Girl, age 8 years (21 meals × 0.5 meal of man), equivalent to	10.5
Girl, age 5 years (21 meals × 0.4 meal of man), equivalent to	8.4
Total number of meals equivalent to	69.3

Equivalent to 1 man for 23 days.

Weights and cost of food and nutrients in dietary study No. 676.

Food consumed during entire study (7 days).		Cost, nutrients, and fuel value of food per man per day.				
Kind and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.						
Pork: Bacon, 2,065 grams, 55 cents (9); lard, 982 grams, 22 cents (83)	*Dollars.* 0.77	*Cents.* 3.3	*Grams.* 8	*Grams.* 109	*Grams.*	*Calories.* 1,002
Butter, 1,015 grams, 45 cents (23)	.45	2.0	....	36	....	320
Milk, 2,160 grams, 43 cents (26)	.43	1.9	3	3	4	55
Buttermilk, 2,325 grams, 23 cents (30)	.23	1.0	3	1	5	41
Total animal food	1.88	8.2	14	149	9	1,118
VEGETABLE FOOD.						
Cereals: Corn meal, 9,678 grams, 39 cents (39); flour, wheat, 6,125 grams, 34 cents (52)	.73	3.2	62	21	513	2,487
Sugars, etc.: Sirup, 4,138 grams, 18 cents (56); sugar, granulated, 585 grams, 6 cents (94)	.24	1.0			168	672
Vegetables: Cabbage, 8,565 grams, 19 cents (63); cowpeas, 2,586 grams, 15 cents (65); potatoes, 13,561 grams, 39 cents (68)	.73	3.2	10	2	177	886
Fruits: Apples, dried, 1,872 grams, 28 cents (73)	.28	1.2	2	2	65	285
Total vegetable food	1.98	8.6	104	25	923	4,330
Total food purchased	3.86	16.8	118	174	932	5,718
Waste, animal and vegetable (125)	....	....	11	17	103	607
Total food eaten	3.86	16.8	107	157	829	5,141

DIETARY STUDY No. 677.

This study was continued seven days. The ages of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 36 years	21.0
Woman, age 32 years (21 meals × 0.8 meal of man), equivalent to	16.8
Boy, age 15 years (21 meals × 0.9 meal of man), equivalent to	18.9
Boy, age 14 years (21 meals × 0.8 meal of man), equivalent to	16.8
Girl, age 12 years (21 meals × 0.6 meal of man), equivalent to	12.6
Girl, age 10 years (21 meals × 0.6 meal of man), equivalent to	12.6
Total number of meals equivalent to	98.7

Equivalent to 1 man for 33 days.

Weights and cost of food and nutrients in dietary study No. 677.

Food consumed during entire study (7 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 2,345 grams, 61 cents (10); lard, 1,121 grams, 24 cents (83)	0.85	2.6	7	86		793
Butter, 2,024 grams, 88 cents (24)	.88	2.7	1	51		458
Milk, 2,465 grams, 49 cents (27)	.49	1.5	2	3	3	47
Buttermilk, 2,362 grams, 25 cents (31)	.25	.7	1		3	16
Total animal food	2.47	7.5	11	140	6	1,314
VEGETABLE FOOD.						
Cereals: Corn meal, 20,686 grams, 83 cents (40); flour, wheat, 3,525 grams, 19 cents (52)	1.02	3.1	62	30	534	2,651
Sugar, etc.: Sirup, 4,635 grams, 21 cents (57); sugar, granulated, 821 grams, 8 cents (94)	.29	.9			138	552
Vegetables: Cabbage, 10,413 grams, 23 cents (63); cowpeas, 2,049 grams, 88 cents (65); potatoes, 10,652 grams, 31 cents (68); turnips, 1,220 grams, 3 cents (69)	1.45	4.4	24	1	104	521
Fruits: Apples, dried, 3,128 grams, 47 cents (75)	.47	1.4	2	2	76	330
Total vegetable food	3.23	9.8	88	33	852	4,054
Total food purchased	5.70	17.3	99	173	858	5,368
Waste, animal and vegetable (126)			14	20	120	714
Total food eaten	5.70	17.3	85	153	738	4,654

DIETARY STUDY No. 678.

This study lasted seven days. The ages of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 29 years	21.0
Woman, age 28 years (20 meals × 0.8 meal of man), equivalent to	16.0
Boy, age 9 years (19 meals × 0.5 meal of man), equivalent to	9.5
Boy, age 7 years (21 meals × 0.5 meal of man), equivalent to	10.5
Girl, age 5 years (21 meals × 0.4 meal of man), equivalent to	8.4
Total number of meals equivalent to	65.4

Equivalent to 1 man for 22 days.

Weights and cost of food and nutrients in dietary study No. 678.

Food consumed during entire study (7 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 3,121 grams, 83 cents (11)	0.83	3.8	12	104	....	974
Milk, 3,206 grams, 6 cents (28)	.06	.3	5	5	7	92
Total animal food	.89	4.1	17	109	7	1,066
VEGETABLE FOOD.						
Cereals: Corn meal, 12,620 grams, 51 cents (41)	.51	2.3	44	25	419	2,074
Sugars, etc.: Sirup, 1,068 grams, 5 cents (58)	.05	.2	....	....	37	148
Vegetables: Cowpeas, 2,148 grams, 9 cents (65); onions, 1,846 grams, 4 cents (66)	.13	.6	23	1	69	377
Fruits: Apples, dried, 763 grams, 11 cents (74)	.11	.5	1	1	28	125
Total vegetable food	.80	3.6	68	27	553	2,724
Total food purchased	1.69	7.7	85	136	560	3,790
Waste, animal and vegetable (127)	....	....	14	19	146	809
Total food eaten	1.69	7.7	71	117	414	2,981

DIETARY STUDY No. 679.

This study lasted seven days. The ages of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 46 years	20.0
Woman, age 40 years (20 meals × 0.8 meal of man), equivalent to	16.0
Girl, age 19 years (21 meals × 0.8 meal of man), equivalent to	16.0
Boy, age 18 years (19 meals)	19.0
Boy, age 17 years (20 meals)	20.0
Girl, age 15 years (21 meals × 0.8 meal of man), equivalent to	16.8
Boy, age 8 years (21 meals × 0.5 meal of man), equivalent to	10.5
Total number of meals equivalent to	118.3

Equivalent to 1 man for 39 days.

Weight and cost of food and nutrients in dietary study No. 679.

Food consumed during entire study (7 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 2,120 grams, 56 cents (12)	0.56	1.4	4	40	....	372
Total animal food	.56	1.4	4	40	....	372
VEGETABLE FOOD.						
Cereals: Corn meal, 21,654 grams, 87 cents (42)	.87	2.2	43	24	403	1,998
Sugars, etc.: Sirup, 1,120 grams, 5 cents (59)	.05	.1	....	....	23	92
Vegetables: Onions, 1,582 grams, 4 cents (66)	.04	.1	1	....	4	20
Fruits: Apples, dried, 1,115 grams, 17 cents (75)	.17	.5	1	1	23	105
Total vegetable food	1.13	2.9	45	25	453	2,215
Total food purchased	1.69	4.3	49	65	453	2,587
Waste, animal and vegetable (128)	....	....	5	8	72	378
Total food eaten	1.69	4.3	44	57	381	2,207

DIETARY STUDY No. 680.

This study was continued seven days. The ages of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 34 years	21.0
Woman, age 30 years (19 meals × 0.8 meal of man), equivalent to	15.2
Boy, age 9 years (21 meals × 0.5 meal of man), equivalent to	10.5
Boy, age 7 years (21 meals × 0.5 meal of man), equivalent to	10.5
Girl, age 5 years (21 meals × 0.4 meal of man), equivalent to	8.4
Girl, age 4 years (21 meals × 0.4 meal of man), equivalent to	8.4
Girl, age 2 years (21 meals × 0.4 meal of man), equivalent to	8.4
Total number of meals equivalent to	82.4

Equivalent to 1 man for 27 days.

Weights and cost of food and nutrients in dietary study No. 680.

Food consumed during entire study (7 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 1,820 grams, 48 cents (13)	0.48	1.8	4	49	....	452
Total animal food	.48	1.8	4	49	....	452
VEGETABLE FOOD.						
Cereals: Corn meal, 17,815 grams, 71 cents (42)	.71	2.6	51	28	478	2,365
Sugars, etc.: Sirup, 2,598 grams, 12 cents (60)	.12	.5	....	....	76	304
Vegetables: Cowpeas, 1,862 grams, 9 cents (65); onions, 432 grams, 2 cents (66)	.11	.4	16	1	44	249
Fruits: Apples, dried, 736 grams, 11 cents (75)	.11	.4	1	1	22	101
Total vegetable food	1.05	3.9	68	30	620	3,019
Total food purchased	1.53	5.7	72	79	620	3,471
Waste, animal and vegetable (129)			10	12	139	703
Total food eaten	1.53	5.7	62	67	481	2,768

DIETARY STUDY No. 681.

This study was continued seven days. The ages of the members of the family, and the number of meals taken, were as follows:

	Meals.
Man, age 33 years	21.0
Woman, age 29 years (21 meals × 0.8 meal of man), equivalent to	16.8
Girl, age 8 years (21 meals × 0.5 meal of man), equivalent to	10.5
Boy, age 7 years (21 meals × 0.5 meal of man), equivalent to	10.5
Girl, age 6 years (21 meals × 0.5 meal of man), equivalent to	10.5
Boy, age 4 years (21 meals × 0.4 meal of man), equivalent to	8.4
Total number of meals equivalent to	77.7

Equivalent to 1 man for 26 days.

Weights and cost of food and nutrients in dietary study No. 681.

Food consumed during entire study (7 days).		Cost, nutrients, and fuel value of food per man per day.				
Kinds and amounts.	Cost.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.	*Dollars.*	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Pork: Bacon, 1,725 grams, 45 cents (14)	0.45	1.7	6	49	....	460
Total animal food	.45	1.7	6	49	....	460
VEGETABLE FOOD.						
Cereals: Corn meal, 19,120, 76 cents (42)	.76	2.9	57	32	533	2,645
Sugars, etc.: Sirup, 1,562 grams, 8 cents (61)	.08	.3	....	....	49	196
Vegetables, etc.: Cowpeas, 2,015 grams, 9 cents (65); onions, 500 grams, 2 cents (66)	.11	.4	18	1	50	281
Fruits: Apples, dried, 822 grams, 13 cents (75)	.13	.5	1	1	25	113
Total vegetable food	1.08	4.1	76	34	657	3,235
Total food purchased	1.08	5.8	82	83	657	3,695
Waste, animal and vegetable (130)	....	....	14	17	158	839
Total food eaten	1.53	5.8	68	66	499	2,856

SUMMARY AND DISCUSSION OF RESULTS.

The statistical results of these eleven studies are summarized in the following table:

Summary of results of eleven dietary studies with Georgia mountaineers (per man per day basis) Nos. 671-681.

Dietary study.	Cost.	Protein.	Fats.	Carbohydrates.	Fuel value.
	Cents.	*Grams.*	*Grams.*	*Grams.*	*Calories.*
No. 671, mountaineer's family	13.7	89	130	694	4,289
No. 672, mountaineer's family	15.8	94	161	783	4,941
No. 673, mountaineer's family	12.8	96	148	853	5,113
No. 674, mountaineer's family	14.1	127	145	1,043	5,970
No. 675, mountaineer's family	14.8	127	158	994	5,890
No. 676, mountaineer's family	16.8	107	157	829	5,141
No. 677, mountaineer's family	17.3	85	153	738	4,654
No. 678, mountaineer's family	7.7	71	117	414	2,981
No. 679, mountaineer's family	4.3	44	57	381	2,207
No. 680, mountaineer's family	5.7	62	67	481	2,768
No. 681, mountaineer's family	5.8	68	66	499	2,856
Average	12.0	86	124	701	4,243

A glance at these figures shows that the diets represented vary widely in cost and in the amount of nutrients and energy supplied. The first seven give noticeably higher results in all respects than the last four. Unfortunately the data reported are not sufficient to explain these individual variations. Some of the families in the first group were in better circumstances than those in the last, which fact may in a measure account for the differences. From the little information available, it seems probable that their muscular activity was in all cases much the same as that of farmers' families elsewhere;

the men probably worked fairly hard and the women sometimes helped in the farm work.

The cost ranged from 17.3 cents to 4.3 cents per man per day, with an average of 12 cents. This is considerably higher than among the similar mountaineer families studied in Tennessee, where the cost was found to average only 7.4 cents per man per day. The higher cost of the Georgia studies is due in large measure to the freer use of vegetables and fruit, and since, as has been already explained, these were home grown, but quoted in the tables as if bought at market prices, the higher cost may be more apparent than real. Whereas in some of the Tennessee studies no vegetables were used, at least one kind appears in each of the present series, and cabbage, string beans, beets, onions, cowpeas, etc., were all in common use. Fruit was also fairly common in the Georgia dietaries. While these articles may not add much protein and energy in proportion to their cost, they must increase the palatability of these very simple diets. Except for the use of vegetables, these diets contained much the same materials as those studied in Tennessee. No fish or beef was used, and butter in only two instances. As far as may be judged from the list of foods, no dessert of any kind was made in any of the families. The cooking and serving were undoubtedly of the simplest. Lack of money and the difficulty of securing other materials in these remote regions would be sufficient explanation for the few kinds of food used. Probably also ignorance of better conditions and long habit render the diets less irksome than they would seem to one accustomed to the usual varied diet.

The protein supplied in the Georgia studies ranged from 44 to 127 grams per man per day, with an average of 86 grams. This is 2 grams more than the average of the Tennessee studies, and considerably below the standard requirement for man at moderately active work. As was found to be the case in the Tennessee studies, the fuel value was relatively much higher than the protein content, ranging from 2,207 to 5,970 calories, with an average of 4,243 calories.

In a few studies in which the fuel value was exceptionally low the energy supplied may not have been entirely sufficient, but in general it may be considered to have met the needs of the subjects. Regarding the adequacy of the protein supplied, the same questions arise as in the Tennessee studies. These people evidently attained fair physical development and satisfied the demands of their appetites on a protein ration considerably below the standard. No exact data are available regarding the physical and sociological conditions of these Georgia families, but anyone familiar with the class of which they are typical will admit that they age rapidly, seem to have comparatively little power to resist disease, such as tuberculosis, and are neither very ambitious nor progressive.

DISCUSSION OF AMERICAN RURAL DIETARIES.

By Charles E. Wait, Ph. D., F. C. S.,
Professor of Chemistry, University of Tennessee.

So much interest is now being felt in all the conditions of life in rural regions that it may not be out of place to use the three sets of studies here reported as a starting point for a brief discussion of the general dietary conditions of the rural population of the United States. Including those here first reported, 140 studies of rural families have been made in various parts of the country by individual experiment stations or under the auspices of the Office of Experiment Stations. Unfortunately, they do not represent all sections, but they are sufficient for some general deductions and comparisons. The average results of the various groups are given in the table following, along with those for studies among other groups of people, and the standard for moderate muscular work.

Average results of dietary studies in American families.

[Quantities per man per day.]

Character and location of families.	Number of studies in average.	Cost.	Protein.	Fuel value.
FARMERS.		*Cents.*	*Grams.*	*Calories.*
Connecticut	10	....	105	3,474
Vermont	4	23.0	104	3,462
Vermont and New York	3	9.0	83	3,508
Average of families in Northeastern States	17	....	97	3,481
Tennessee, in or near towns	44	9.3	85	3,668
Tennessee, remote mountain regions	19	7.4	82	3,731
Average of families in Tennessee	63	8.8	84	3,674
Georgia, mountaineers	11	12.0	86	4,243
Average of Georgia and Tennessee families	74	....	84	3,759
Georgia, negro family	1	15.4	56	4,105
Alabama, negro families	20	8.0	62	3,167
Virginia, negro families	19	11.0	109	3,627
New Mexico, Mexican farmers' families	3	6.3	93	3,640
California, Chinese farm laborers	1	20.0	144	4,100
Average of 9 groups American rural families	....	....	93	3,730
POOR IN LARGE CITIES.				
Destitute families	15	....	69	2,275
Poor families	25	9.0	84	2,653
Families in varying circumstances, congested districts	55	20.9	119	3,489
PERSONS IN COMFORTABLE CIRCUMSTANCES.				
Men at hard muscular work:				
Artisans, laborers, etc	24	....	177	6,485
Athletes	19	....	198	4,980
Men at moderate muscular work: Farmers, artisans, laborers, etc	162	....	100	3,685
Men not employed at muscular occupations: Business men, students, etc	51	....	106	3,560
Men with little or no muscular work: Inmates of institutions	49	....	86	2,820
American standard for man at moderate muscular work	....	....	100	3,500

Besides the Vermont studies here first reported, studies were reported[a] by W. O. Atwater and his associates as part of the work of the Connecticut (Storrs) Experiment Station, some years earlier, one among farmers' families in Connecticut, and the others on farms in Vermont and northeastern New York. The families among whom the earlier studies were made corresponded in general circumstances to those described in the first section of this bulletin, so that they may all be taken together as typical of the diet of moderately well-to-do farmers in the Northeastern States. Accordingly, it appears that the diet of such families agrees surprisingly closely with the accepted standard for persons at moderate muscular work, both in the amount of protein supplied and in fuel value. Although there is no statistical proof at hand, it is the general impression that farmers' families in similar circumstances throughout the North, South, and West are equally well nourished. If there are faults in the diet they are due, as is the case in families in similar circumstances in cities and towns, rather to the wrong choice of foods and poor methods of preparation than to insufficient quantities. It is unfortunate that there have been found on record no available dietary studies of farmers' families in comfortable circumstances in other regions of the United States which can be compared with those made in New England and New York. In all regions of the United States the number of such families is large and perhaps the most numerous group of the rural population. Such studies are needed before general deductions can be drawn.

In the dietaries of families of farmers in comfortable circumstances in the Northeastern States there was a considerable variety of food materials used. Some, notably Nos. 602 and 603, were excellent illustrations of the fact that with intelligence and care a varied and yet moderate-priced diet may be obtained as well on the farm as anywhere else. Although the city housewife may have the advantage in the matter of fancy groceries and fruit, baker's and confectioner's goods, and the like, her sister on the farm can frequently obtain such staples as poultry, eggs, dairy products, vegetables, and native fruits in better condition and for less outlay, and it is upon these rather than upon the more fancy articles that the attractiveness of a wholesome home table depends.

While the number of farms in which the cooking and serving are as good as in corresponding town or city homes is large, in very many others these features of the diet are not as well provided for as the means of the family would permit. This difference is undoubtedly due, at least in part, to the greater number of kitchen and household conveniences in the city homes. The rural population is, however, com-

[a] Conn. (Storrs) Sta. Rpts. 1895, p. 114; 1896, p. 117; 1897, p. 130.

ing more and more to recognize the importance of running water, ice supplies, good drainage, and other conveniences, not only in saving labor for the housekeepers, but in raising the standard of home life. To have meals well cooked and appetizing is perhaps as important as to have them adequate. It is an attested physiological fact that a pleasing variety in diet actually stimulates digestion and that the amount of nutrients in the food eaten which can be made available to the body for nourishment by the digestive organs depends in considerable measure on the way in which it is cooked.

There is another equally important consideration: No one thing tends more to increase the pleasure and grace of family intercourse than well-prepared meals, carefully served and decorously eaten. Such meals depend more on the intelligence and care of the homemakers than they do on expensive materials. These and other related points are being more and more impressed upon the people in the towns and on the farms by the courses offered in domestic science and arts in agricultural colleges and other schools, by the various educational extension movements of towns and States, by the Department of Agriculture, and by other agencies of the kind throughout the country. It seems not unreasonable to hope that before many years the dietary and other conditions of home life will be as well developed in homes where such changes are needed.

There are, unfortunately, certain groups of people of this country who seem out of the track of general progress and among whom the standards of living have for years remained low. Prominent among these are two groups in the Southeastern States, the white mountaineers and the negroes, in such regions as the so-called "black belt." Thanks to the cooperation of officers of the Hampton Normal and Agricultural Institute, the Tuskegee Normal and Industrial Institute, and the Agricultural and Mechanical College of Alabama, the Office has been able to carry out dietary studies (summarized in the table on page 137) which throw light on the food habits of groups of typical negroes in agricultural districts of Virginia and Alabama.[a] As was found in the studies among white mountaineers reported in the present bulletin, the general conditions of life among these negroes are of the simplest, except where the influence of such institutions as those mentioned above is raising the standard—a most excellent and constantly increasing influence. In many cases they cultivate small farms in a primitive and unprofitable fashion, live in poorly built cabins, and in general exist in a rather "hand-to-mouth" way. Most of the cooking is done on the hearth, and the food materials most commonly used are the same as those noted among the mountaineers.

Another smaller but quite distinctive class are the small Mexican

---

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 38 and 71.

farmers who, although living in New Mexico and elsewhere in the Southwestern United States, retain the characteristic habits of old Spanish Mexico. The dietary studies summarized in the table on page 137 were made among them some years ago,[a] and it was found that they obtained a fairly well-balanced ration at remarkably low cost. One of the striking features of the dietaries was the abundant use of the native beans, called "frijoles," which are an unusually cheap source of protein. This is parallel with the use of other legumes among certain Asiatic nations, notably the Japanese, who are commonly supposed to obtain little protein because they eat little meat, but who really in many cases obtain largely from soy-bean products and other vegetable foods and from fish as much protein per kilogram of body weight as Europeans.

These New Mexican dietaries are the lowest priced of those included in the nutrition investigations of the Office of Experiment Stations. They cost only 6.3 cents a day and furnished 93 grams of protein and 3,640 calories of energy. Their fuel value is slightly lower than that of either group of the Tennessee studies. Next to them in point of economy come the nineteen studies made in remote districts of Tennessee, which furnished 12 grams less protein and 271 calories more energy at 0.4 cent more. Third in point of cheapness are the Alabama negro dietaries. These are very similar to the Tennessee dietaries in general character, as has been pointed out, both consisting largely of the "hog and hominy," characteristic of the diet of poor whites and negroes alike in the Southeastern States.

The proportion of pork to cereals is larger in the Alabama studies than in those in Tennessee, and consequently there is less protein (62 grams) in proportion to the fuel value (3,167 calories). The cost is about midway between that of the remote and that of the village studies in Tennessee. Considering the smaller amounts and poorer proportion of protein and energy, however, the Alabama dietaries are inferior in real economy. In the studies among negroes in eastern Virginia, 11 cents purchased 109 grams of protein and 3,627 calories of energy. When it is remembered that in the higher priced Tennessee studies an average expenditure of 11.2 cents furnished only 98 grams of protein, it appears that the Virginia negroes obtained their protein more cheaply than their white neighbors in Tennessee. This difference is due to the fact that the Virginia studies were made in a district near the seashore where a cheap and abundant supply of fish furnished nearly half of the total protein. The Alabama dietaries are probably more typical of the poorer negroes throughout the South.

The Georgia negro dietary here first reported (No. 670) probably represents a family in rather better circumstances than the average

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 40 and 54.

of those just discussed. Its comparatively high cost and low protein place it outside of the economical and well-balanced studies of this type.

The Georgia mountaineer dietaries, although similar to those in Tennessee in general character, are more expensive, but at the same time slightly more varied and nutritious. Probably the differences between the dietaries in the two States would appear less were it possible to reduce both to the same scale of market prices and to include a larger number of Georgia studies in the average.

As was implied in an earlier section, these mountaineer families stand financially in much the same relation to the bulk of the rural population as do the poor in the crowded sections of the cities to the city dwellers at large. It may therefore be interesting to compare their dietaries with those of families in congested quarters of New York, Chicago, and elsewhere.[a] The 15 families described as destitute in the table on page 137 were living below what is known as the "poverty line," and would undoubtedly have eaten more could they have afforded it. They paid almost twice as much for their food as the Tennessee mountaineers, but obtained only four-fifths the amount of protein and two-thirds the fuel value. Although they probably obtained a greater variety, it must be conceded that in such cases quantity and wholesomeness are more important than variety. The 25 families in New York City and elsewhere represent poverty of a less acute kind. Here the cost averaged 9 cents, the protein 84 grams, and the energy 2,653 calories. The other 55 New York studies were made among families with means above the "poverty line." They paid 2½ to 3 times as much for their food as the Tennessee mountaineers, but obtained an ample supply of nutrients and energy with considerable variety of materials. Except in extreme cases, the city poor, judged by the data quoted, appear to be better nourished than the mountaineers and pay more for their food.

The remaining dietaries quoted in the table represent families of different kinds in moderately comfortable circumstances in various cities and towns of the United States. In all these dietaries the energy is above the standard for moderately active work and in many cases probably in excess of the needs of the families. These dietaries do not furnish nutrients as cheaply as those from Tennessee, Georgia, and New Mexico, where the foods were mostly home grown and the variety very limited, but they are much more varied and appetizing, and probably well within the means of the families using them.

In general, it may be said that the mountaineer studies represent dietaries about midway in economy and nutritive value between the New Mexican ones and those of the Alabama negroes. Compared with

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 46 and 55.

the dietaries of city families in corresponding financial conditions, they cost much less and furnish about the same amounts of energy, but are low in protein and also lacking in variety. Data are not available for discussing at length the quality of cooking of these mountaineer families as compared for instance with that of the city poor whom they resemble in some other ways, as pointed out above, but it was certainly the opinion of those making the studies that in few of the families was the food well cooked or the diet even reasonably attractive to a person with the usual standards of living. Compared with the dietaries of families in fairly comfortable circumstances throughout the country, the same advantages and disadvantages appear—low cost, sufficient energy, but a striking deficiency of protein, and a lack of variety in the materials used. Could these families be made to realize the importance and comfort of such improvements and conveniences in living as are already found or are coming to be appreciated in many other sections of the country, their dietary habits could undoubtedly be improved at very little increase of cost, and hand in hand with such a change would go an equally important improvement, not only in their physical but also in their social and other conditions. One of the most useful functions of dietary studies, such as those here reported, is, by pointing out existing errors, to pave the way for improvement.

[Cir. 221]

O

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION.

NOTE.—Publications marked with an asterisk (*) are not available for distribution.

BULLETINS.

*Bul. 36. Notes on Irrigation in Connecticut and New Jersey. By C. S. Phelps and E. B. Voorhees. Pp. 64.
*Bul. 58. Water Rights on the Missouri River and its Tributaries. By Elwood Mead. Pp. 80.
*Bul. 60. Abstract of Laws for Acquiring Titles to Water from the Missouri River and its Tributaries, with the Legal Forms in Use. Compiled by Elwood Mead. Pp. 77.
Bul. 70. Water-right Problems of Bear River. By Clarence T. Johnston and Joseph A. Breckons. Pp. 40.
*Bul. 73. Irrigation in the Rocky Mountain States. By J. C. Ulrich. Pp. 64.
*Bul. 81. The Use of Water in Irrigation in Wyoming. By B. C. Buffum. Pp. 56.
*Bul. 86. The Use of Water in Irrigation. Report of investigations made in 1899, under the supervision of Elwood Mead, Expert in Charge, and C. T. Johnston, assistant. Pp. 253.
*Bul. 87. Irrigation in New Jersey. By Edward B. Voorhees. Pp. 40.
*Bul. 90. Irrigation in Hawaii. By Walter Maxwell. Pp. 48.
*Bul. 92. The Reservoir System of the Cache la Poudre Valley. By E. S. Nettleton. Pp. 48.
*Bul. 96. Irrigation Laws of the Northwest Territories of Canada and of Wyoming, with Discussions by J. S. Dennis, Fred Bond, and J. M. Wilson. Pp. 90.
*Bul. 100. Report of Irrigation Investigations in California, under the direction of Elwood Mead, assisted by William E. Smythe, Marsden Manson, J. M. Wilson, Charles D. Marx, Frank Soulé, C. E. Grunsky, Edward M. Boggs, and James D. Schuyler. Pp. 411.
*Bul. 104. Report of Irrigation Investigations for 1900, under the supervision of Elwood Mead, Expert in Charge, and C. T. Johnston, assistant. Pp. 334. (Separates only.)
*Bul. 105. Irrigation in the United States. Testimony of Elwood Mead, Irrigation Expert in Charge, before the United States Industrial Commission, June 11 and 12, 1901. Pp. 47.
Bul. 108. Irrigation Practice Among Fruit Growers on the Pacific Coast. By E. J. Wickson. Pp. 54.
*Bul. 113. Irrigation of Rice in the United States. By Frank Bond and George H. Keeney. Pp. 77.
Bul. 118. Irrigation from Big Thompson River. By John E. Field. Pp. 75.
*Bul. 119. Report of Irrigation Investigations for 1901, under the direction of Elwood Mead, Chief. Pp. 401. (Separates only.)
Bul. 124. Report of Irrigation Investigations in Utah, under the direction of Elwood Mead, Chief, assisted by R. P. Teele, A. P. Stover, A. F. Doremus, J. D. Stannard, Frank Adams, and G. L. Swendsen. Pp. 330.
*Bul. 130. Egyptian Irrigation. By Clarence T. Johnston. Pp. 100.
*Bul. 131. Plans of Structures in Use on Irrigation Canals in the United States, from drawings exhibited by the Office of Experiment Stations at Paris, in 1900, and at Buffalo, in 1901, prepared under the direction of Elwood Mead, Chief. Pp. 51.
*Bul. 133. Report of Irrigation Investigations for 1902, under the direction of Elwood Mead, Chief. Pp. 266.
Bul. 134. Storage of Water on Cache la Poudre and Big Thompson Rivers. By C. E. Tait. Pp. 100.
*Bul. 140. Acquirement of Water Rights in the Arkansas Valley, Colorado. By J. S. Greene. Pp. 83.
*Bul. 144. Irrigation in Northern Italy—Part I. By Elwood Mead. Pp. 100.
*Bul. 145. Preparing Land for Irrigation and Methods of Applying Water. Prepared under the direction of Elwood Mead, Chief. Pp. 84.
*Bul. 146. Current Wheels: Their Use in Lifting Water for Irrigation. By Albert Eugene Wright. Pp. 38.
*Bul. 148. Report on Irrigation Investigations in Humid Sections of the United States in 1903. Pp. 45.

[Continued on third page of cover.]

1225 Issued January 28, 1910.

U. S. DEPARTMENT OF AGRICULTURE,

OFFICE OF EXPERIMENT STATIONS—BULLETIN 222.

A. C. TRUE, Director.

IRRIGATION IN TEXAS.

BY

J. C. NAGLE,

Professor of Civil Engineering, Agricultural and Mechanical College of Texas.

PREPARED UNDER THE DIRECTION OF

SAMUEL FORTIER,

Chief of Irrigation Investigations.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1910.

OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.
E. W. ALLEN, Assistant Director.

IRRIGATION INVESTIGATIONS.

SAMUEL FORTIER, Chief.
R. P. TEELE, Editorial Assistant and Acting Chief in absence of the Chief.

IRRIGATION ENGINEERS AND IRRIGATION MANAGERS.

A. P. STOVER, Irrigation Engineer, in charge of work in Oregon.
C. E. TAIT, Irrigation Engineer, in charge of work in Imperial Valley and Arizona.
S. O. JAYNE, Irrigation Manager, in charge of work in Washington.
W. W. MCLAUGHLIN, Irrigation Engineer, in charge of work in Utah.
P. E. FULLER, Irrigation Engineer, in charge of power investigations.
W. L. ROCKWELL, Irrigation Manager, in charge of work in Texas.
D. H. BARK, Irrigation Engineer, in charge of work in Idaho.
MILO B. WILLIAMS, Irrigation Engineer, in charge of work in humid sections.
V. M. CONE, Irrigation Engineer.

COLLABORATORS.

O. V. P. STOUT, University of Nebraska, in charge of work in Nebraska.
GORDON H. TRUE, University of Nevada, in charge of work in Nevada.
W. B. GREGORY, Tulane University of Louisiana, in charge of rice irrigation in Louisiana and Texas.
F. L. Bixby, New Mexico Agricultural College, in charge of work in New Mexico.

IRRIGATION FARMERS.

JOHN H. GORDON, R. G. HEMPHILL, W. H. LAUCK, R. E. MAHONEY, and JOHN KRALL, Jr.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., October 4, 1909.

Sir: I have the honor to transmit herewith a report on irrigation in the State of Texas, prepared by J. C. Nagle, professor of civil engineering, Agricultural and Mechanical College of Texas, under the direction of Samuel Fortier, chief of irrigation investigations of this Office. This is one of a series of reports giving the status of irrigation in the several arid States at the time they were prepared. This report on Texas is based on data collected in 1908, and refers to that year. Development has been rapid since that time, and conditions in some sections have changed since the report was prepared. There is a very large call upon this Office for general information regarding the opportunities for settlement on irrigated lands, the cost of land and water and of establishing homes on these lands, and regarding the crops grown. The attempt has been made to include in each of these reports as nearly as possible all the information which will be needed by persons contemplating settlement in the State to which it refers. It is recommended that the report be published as a bulletin of this Office.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATION.

IRRIGATION IN TEXAS.

GENERAL DESCRIPTION.

Texas lies in the extreme southern part of the Great Central Plain. Its area is 265,896 square miles, or 170,173,440 acres, nearly one-ninth of the total area of continental United States, excluding Alaska. States the size of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, and South Carolina could be carved out of it and there would still remain an area equal to one-third that of Pennsylvania. The State extends through 9.5° of latitude and nearly 13° of longitude. Texline, located 10 miles south of the northern boundary, is only 50 miles south of Cairo, Ill., while Brownsville, 800 miles farther south, near the extreme southern part of the State, is in the same latitude as Miami, Fla. The eastern boundary of the State is but a few miles west of the meridian passing just east of St. Paul, Minn., while El Paso, 750 miles west and near the extreme western part of the State, is nearly 100 miles west of Denver and on approximately the same meridian as Glasgow, Mont. (Pl. I.)

There are 245 counties in the State, the smallest, Rockwall, having an area of only 143.75 square miles, while El Paso, the largest, has an area of 9,280 square miles, or more than seven and one-half times that of the State of Rhode Island.

According to the census of 1900, Texas had a population of 3,048,710 and ranked sixth among the States. The average population per square mile was 11.6 as compared with 25.6 for the United States, or 129.8 for the North Atlantic States. The population of the State by the censuses since 1850 is as follows:

Population of Texas by United States Census, 1850–1900.

Year.	Population.	Year.	Population.
1850	212,592	1880	1,591,749
1860	602,215	1890	2,235,527
1870	818,579	1900	3,048,710

Prof. F. M. Bralley, general agent of the conference of education in Texas, estimated the population in 1906 as 3,536,618, and it is

expected that by the next census it will have reached 4,000,000. In bringing about this increase, irrigation and intensive cultivation are to play an important part. They have already rendered profitable large areas which up to a few years ago were considered worthless for agricultural purposes.

TOPOGRAPHY.

Texas has a frontage of 400 miles on the Gulf of Mexico, and slopes back to the north and west to elevations of 4,000 to 9,500 feet. The following are the highest points in the State:

Elevations of points in Texas.

Name.	Feet.
Guadalupe Peak, El Paso County	9,500
Mount Emery, Brewster County	9,000
Mount Livermore, Jeff Davis County	8,400
Paisano, on the Southern Pacific Railroad, 700 miles west of Beaumont and 621 miles west of Houston	5,078

Between one-third and one-fourth of the State is less than 500 feet elevation, and perhaps two-fifths is less than 1,000 feet. The Llano Estacado, or Staked Plains, covering about 18,000 square miles, ranges from 3,000 to 4,000 feet in elevation, but appears to be almost level, owing to its very gradual slope.

CLIMATE.

Such wide ranges in latitude, longitude, and elevation give rise to wide variations in temperature and rainfall. The mean annual rainfall for portions of the State bordering on the coast approaches 50 inches, while at El Paso it is little more than 9 inches. The recorded temperatures of the State range from 16° F. below zero, the absolute minimum at Big Spring, to 117° above, the maximum at Amarillo. According to newspaper statements, at the same hour during the winter of 1908, the thermometer stood at 16° below zero at Texline and at 84° above at Brownsville, 800 miles farther south.

The following tables of monthly rainfall, mean, highest, and lowest temperatures, and frost data, are taken from the publications of the U. S. Weather Bureau, and wherever possible the number of years covered by the means is given. The data are given for a few stations only. These are divided into seven groups, corresponding to the arbitrary grouping of data on existing irrigation systems which will follow. The stations were selected so as to give as nearly as possible average values for the rainfall in the sections surrounding them. The values include data for 1907, except for Menardville, which includes nothing after 1903.

Mean monthly and annual rainfall.

Group.	Section.	Length of record.	January.	February.	March.	April.	May.	June.
		Years.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
I.	Orange and Beaumont	25	2.83	3.61	2.90	2.71	3.01	5.02
I.	Houston	26	4.13	3.50	3.79	3.80	5.14	5.20
I.	Danevang	12	3.16	3.35	2.95	3.88	3.15	4.35
II.	Beeville	13	1.23	2.16	2.11	2.64	3.18	2.88
II.	Laureles and Santa Gertrudes ranches	9	.87	2.63	2.08	1.85	2.31	2.73
II.	Brownsville	37	1.38	1.44	1.33	1.19	2.16	2.25
III.	San Antonio	36	1.46	1.65	1.80	2.76	3.10	2.82
III.	Eagle Pass—Fort Duncan	32	.75	.85	1.13	1.60	3.13	2.58
IV.	Mount Blanco	22	.66	.88	.58	1.91	2.11	3.04
IV.	Hale Center	14	.29	.53	.48	1.71	2.43	3.24
IV.	Amarillo—Fort Elliott	28	.62	.69	.55	2.11	3.67	3.08
V.	Menardville	15	1.30	1.20	.80	.90	1.70	3.20
VI.	Fort Stockton	30	.40	.43	.65	.47	1.50	1.92
VI.	Fort Davis	33	.54	.50	.39	.54	1.04	1.95
VII.	El Paso [a]	29	.54	.49	.34	.24	.36	.59

Group.	Section.	Length of record.	July.	August.	September.	October.	November.	December.	Annual.
		Years.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
I.	Orange and Beaumont	25	4.70	4.18	2.78	2.92	4.03	3.22	41.91
I.	Houston	26	3.84	4.05	4.54	3.30	4.05	3.09	48.43
I.	Danevang	12	5.02	3.66	3.86	4.50	3.98	4.01	45.87
II.	Beeville	13	3.95	1.92	2.79	2.78	2.19	1.73	29.56
II.	Laureles and Santa Gertrudes ranches	9	2.43	1.87	3.23	2.41	2.44	1.44	26.29
II.	Brownsville	37	1.87	2.78	5.76	3.27	2.19	1.45	27.07
III.	San Antonio	36	2.49	2.61	3.59	1.99	2.25	1.78	28.30
III.	Eagle Pass—Fort Duncan	32	1.78	2.58	3.50	1.65	1.12	.93	21.60
IV.	Mount Blanco	22	3.30	2.59	2.24	2.18	1.16	.61	21.26
IV.	Hale Center	14	4.04	2.41	2.80	1.41	1.23	.62	21.19
IV.	Amarillo—Fort Elliott	28	2.38	3.08	2.10	1.99	.88	.84	22.39
V.	Menardville	15	3.00	1.80	2.10	3.30	1.80	1.50	22.60
VI.	Fort Stockton	30	2.07	2.33	3.22	1.43	.75	.72	15.89
VI.	Fort Davis	33	3.47	3.59	2.95	1.34	.60	.58	17.46
VII.	El Paso [a]	29	2.10	1.73	1.41	1.05	.58	.52	9.93

[a] 1879 to 1907, inclusive.

The following tables on mean, highest, and lowest temperatures and frost data contain data for some stations not included in the rainfall table, but are fairly representative of the groups with which they are given.

Highest, lowest, and mean temperatures at stations in Texas.

Group.	Stations.	Length of record.	Highest.		Lowest.		Mean annual, °F.
			°F.	Month.	°F.	Month.	
		Years.					
	Houston	19	104	July	6	February	68.4
	Galveston	35	98	do	8	do	69.4
I	Columbia	18	102	do	5	do	68.8
	Danevang	12	104	do	3	do	69.2
	Victoria	10	104	August	6	do	70.6
	Beeville	12	107	June	5	do	70.5
	Corpus Christi	19	98	July-August	11	do	70.0
II	Brighton	12	102	July	7	do	71.0
	Brownsville	16	102	June, July, September.	12	do	72.7
	Fort McIntosh	22	111	June	5	do	72.4
	Eagle Pass	19	111	July	7	do	70.7
III	Fort Clark	21	109	June	10	do	69.7
	Kerrville	13	105	August	− 2	do	64.0
	Hondo	8	105	June	14	do	
	San Antonio	21	106	July	4	do	67.9
	Mount Blanco	20	110	June	−14	do	60.3
IV	Amarillo—Fort Elliott		108	do	−16	do	55.1
	Hale Center	13	108	July	− 8	do	60.3
V	Menardville	15	108	do	3	March	64.0
VI	Fort Stockton	12	114	June	2	February	62.8
	Fort Davis	18	111	do	− 3	do	60.2
VII	El Paso	33	[a]113	do	− 5	December	62.9

[a] Believed to be too high, as instruments were improperly exposed during first few years of record.

Frost data at stations in Texas.

Group.	Stations.	Length of record.	Average date of first killing frost in autumn.	Average date of last killing frost in spring.	Earliest date of killing frost in autumn.	Latest date of killing frost in spring.
		Years.				
	Houston		Nov. 24	Feb. 20	Nov. 4	Mar. 26
	Galveston	37	Dec. 26	Feb. 3	Dec. 4	Mar. 1
I	Columbia	14	Nov. 25	Feb. 25	Oct. 27	Mar. 24
	Danevang	12	Nov. 23	Feb. 24	Oct. 26	Do.
	Victoria	7	Dec. 11	Feb. 20	Nov. 12	Mar. 20
	Beeville	13	Dec. 7	Feb. 16	Oct. 27	Mar. 6
II	Corpus Christi	21	Dec. 26	Feb. 20	Nov. 30	Mar. 19
	Brighton	14	Dec. 13	Feb. 13	Nov. 12	Feb. 25
	Brownsville		Dec. 18	Feb. 15	Nov. 15	Mar. 5
	Fort McIntosh	15	Nov. 28	do	Nov. 11	Mar. 3
	Eagle Pass	14	Nov. 21	Feb. 27	Oct. 27	Mar. 22
III	Fort Clark		Nov. 20	Feb. 23	Nov. 2	Mar. 20
	Kerrville	13	Nov. 8	Mar. 21	Oct. 24	Apr. 10
	Hondo	7	Nov. 19	Feb. 28	Nov. 12	Mar. 21
	San Antonio	23	Nov. 28	Feb. 24	Nov. 9	Mar. 20
IV	Mount Blanco	16	Oct. 31	Apr. 9	Oct. 18	May 4
	Hale Center	11	Oct. 30	Apr. 2	Oct. 20	Apr. 30
V	El Paso	29	Nov. 11	Mar. 20	Oct. 30	Apr. 22

NATURAL RESOURCES.

In the extreme eastern and southeastern parts of the State there are splendid forests of longleaf and loblolly pine, which are being converted rapidly into building lumber. Farther west, but still in the eastern part, are large bodies of oak, ash, and other hardwoods, which are being used for manufacturing furniture. Fine live-oak trees are found in portions of the country along the coast in the eastern part of the State, but farther south, where the rainfall is less, all other timber

growths are replaced by chaparral, mesquite, and similar trees. The western part of the State, except the tops of the higher mountains, is generally treeless, but for mesquite and chaparral. The mountain tops are covered with pine and hardwoods. In the central part of the State fine groves of pecan, hackberry, cottonwood, and similar trees are frequently found along the water courses. The gathering of pecans has become quite an industry in the west-central part of the State, and the trees are being cultivated and improved systematically at Brownwood and other places. The Staked Plains are devoid of natural timber, but in many places excellent trees can be grown even without irrigation, although in the more arid regions it is necessary. Practically the entire northeastern part of the State is a Tertiary formation and is crossed by several forest strips of post oak, intermingled with many other kinds of trees. These strips are usually about 10 miles wide and extend 100 miles or more in a northeasterly and southwesterly direction. The timber is used for fuel principally.

Large portions of the Tertiary formation in the eastern and east-central parts of the State are underlaid with vast deposits of lignite. In one case a deposit with a thickness of at least 9 feet was traced for a distance of practically 3 miles. It was not possible to work the deposit, as it was located 9 or 10 miles from a railroad and the railroad company could not be induced to construct a branch. The lignite in the vicinity of Rockdale, Calvert, Laredo, Eagle Pass, and a few other points near railroads is mined and shipped to many places to use for power generation. A project to construct an enormous producer-gas plant near Rockdale to generate electricity to be transmitted to neighboring towns and even to Dallas, Waco, and Houston, has been mentioned. Bituminous coal is mined near Thurber and El Paso and deposits are known to exist at other points. Crude oil and natural gas are found at a number of points in the State and are extensively used for power generation, being cheaper than coal for that purpose. Large deposits of workable iron are found at Rusk and others are known to exist at many other places.

The principal development that has been made in the State outside of the cattle industry is agricultural. Manufacturing industries of many kinds are beginning to spring up. There are more than a dozen cotton mills in operation, but this should be only the beginning. The State operates an iron furnace with convict labor at Rusk. Smelters for reducing gold, silver, copper, and other ores are operated in the vicinity of El Paso. Plants for manufacturing cast-iron articles and for the fabrication of structural steel and iron are operated at Beaumont, Houston, Dallas, and other places. As yet there are no steel-rolling mills in the State.

TRANSPORTATION.

Railroad development in Texas has been greatest in the eastern and central parts of the State, and fully half the mileage lies in the eastern third of the State. The Texas Railroad Commission, in its report for 1907, placed the total mileage of steam roads at 12,575.56. R. A. Thompson, engineer for the commission, estimates that 341.18 miles additional had been built to June 30, 1908. Besides the steam roads, there were about 112 miles of electric interurban roads and some 300 miles of logging or private roads.

While Texas ranks first among the States in railroad mileage, the traffic of the State by inland waterways is very limited. Operations are in progress having in view the improvement of the Trinity and Brazos rivers and Buffalo Bayou and the construction of a coastal canal. Galveston, in point of export shipments, is probably the principal port of the Gulf and South Atlantic States.

TAXATION.

The total valuation of all property assessed for the year ending August 31, 1907, was $1,636,297,115, according to the annual report of the comptroller of public accounts. This was a net increase of $414,137,246 over the previous year. The total taxes assessed for the year 1907, including State, poll, and county, were $7,320,227.64.

EDUCATION.

Texas has a larger permanent endowment for public schools than any other State, but owing to the small amount supplied by local taxation the expenditure per pupil in attendance—$12.76 in 1906—was just half the average for the entire United States. This is being increased, however, as many communities are forming independent school districts.

Texas has a large number of denominational colleges and universities, as well as a state university, the main branch of which is at Austin and the medical department at Galveston. The Agricultural and Mechanical (land-grant) College, receiving aid from the United States Government under the Morrill acts, is located at College Station, and offers inexpensive education in agricultural and engineering lines. State normal schools are maintained at Huntsville, San Marcos, and Denton, and the State Normal and Industrial College for Girls is also located at Denton. There is a state normal and industrial college for negroes at Prairie View, in Waller County. This college shares with the Agricultural and Mechanical College in federal aid under the Morrill acts. An agricultural experiment station, supported mainly by federal funds under the Hatch and Adams acts is organized

as a department of the Agricultural and Mechanical College, and is located at College Station. Substations supported by state funds are maintained at Beeville, Troup, and Chillicothe. The U. S. Department of Agriculture maintains experimental farms at Brownsville and San Antonio, and has conducted special experiments in different parts of the State.

CROPS.

The following statistics regarding some of the principal crops of the State have been compiled from the Yearbook of the U. S. Department of Agriculture for the year 1907:

Crop of 1907.

Crop.	Area.	Production.	Value.	Yield per acre.	Value per acre.
	Acres.				
Corn	7,409,000	155,589,000 bushels	$93,353,000	21 bushels	$12.60
Wheat	380,000	2,812,000 bushels	2,784,000	7.40 bushels	7.33
Oats	500,000	9,500,000 bushels	5,700,000	19 bushels	11.40
Barley	4,000	68,000 bushels	50,000	17 bushels	12.50
Rye	4,500	45,000 bushels	45,000	10 bushels	10.00
Potatoes	33,000	2,409,000 bushels	2,529,000	73 bushels	76.64
Hay	380,000	494,000 tons	5,310,000	1.30 tons	13.97
Cotton	9,156,000	2,300,179 bales			
Tobacco	500	350,000 pounds	105,000	700 pounds	210.00
Rice	284,000	9,088,000 bushels	7,725,000	32 bushels	27.20

Texas was credited with the production of 12,000 long tons of cane sugar, but the acreage and value were not given. The value of the cotton crop was not given by States, but from the total for the whole of continental United States, the proportion of Texas was worth something more than $125,000,000. For 1907 the cotton production was low; during 1906, with only 8,894,000 acres, the production amounted to 4,174,206 bales of 500 pounds each, and in 1908 the crop was 3,814,485 bales, the acreage being 9,316,000.

Details for sugar-cane acreage, sorghum, cotton-seed oil products, turpentine, fruit, garden truck, etc., were not obtainable.

There were 1,278,000 head of horses, worth $83,070,000; 637,000 mules, worth $57,967,000; 1,072,000 milch cows, worth $27,872,000; 7,825,000 other cattle, worth $93,900,000; 1,300,000 sheep, producing 8,450,000 pounds of washed and unwashed wool; and 3,147,000 swine, worth $16,522,000.

For the year 1908 it is probable that the quantities and values of many of the above products have been materially increased, except cotton and cotton-seed products.

WATER RESOURCES.

The water resources of Texas have only begun to be developed. There are millions of acres of arable land within the State susceptible of cultivation under irrigation to a degree limited only by the amount

of water available. Rice irrigation has been developed along the coast, but in addition to large areas still available in that section there are vast bodies of rich bottom land along the lower reaches of the principal rivers which can be irrigated by pumping for the cultivation of rice, sugar cane, alfalfa, and other crops. Toward the sources of such streams as the Brazos, the Colorado, and the Wichita rivers, where the rainfall is of periodic occurrence, and the land normally arid or semiarid, it is possible to construct impounding reservoirs to conserve the run-off. There are areas in eastern and central Texas also where the rainfall is more uniformly distributed and the amount is ordinarily sufficient to raise good crops on which irrigation could be made to pay as an adjunct to the rainfall, particularly in the cultivation of fruits and vegetables.

In the western portion of the State large areas have been regarded as practically desert. This land is very fertile when touched by water, and it would seem possible to construct reservoirs to conserve the run-off from the steep mountain sides during heavy rains which are of such short duration that the greater part of the water runs off. Irrigation in the vicinity of El Paso and Del Rio, and in the Laguna district of Coahuila, Mexico, shows conclusively that all these lands need to convert them from desert wastes into fertile farms is water. Attempts to cultivate crops without irrigation in these regions can result only in failure, as has been demonstrated along the line of the Southern Pacific Railroad beyond Del Rio.

RIVER SYSTEMS.

With the exception of Wichita River, Pease River, Prairie Dog Fork, and the direct drainage along the eastern portion of the northern border of the State, the water from which area reaches the Gulf of Mexico by way of the Red and the Mississippi rivers, the river systems in Texas flow southeast and empty directly into the Gulf of Mexico. Reckoning from east to west the principal systems of this group are the Sabine, Neches, Trinity, San Jacinto, Brazos, Colorado, Guadalupe, San Antonio, Nueces, Pecos, and Rio Grande rivers. Of these the Trinity, Brazos, and Colorado are the principal ones which lie almost wholly within the State and drain vast areas of land.

SABINE RIVER.

The Sabine River, which forms the boundary between Louisiana and Texas for nearly 200 miles, heads in Hunt and Collin counties and flows southeasterly for 150 or 200 miles to the state line, then turns south and finally empties into Sabine Lake. At the lower end of the channel which forms the outlet to this lake is situated Port Arthur, a harbor for vessels of light draft. The river is navigable for small boats for a considerable distance above its mouth.

The drainage area of the Sabine River above Orange, in Texas, is about 7,500 square miles. On the lower portions of the stream are many rice-irrigation systems. Higher up on the watershed are several small power plants which utilize heads ranging from 5 to 25 feet. On account of the fairly uniform distribution of rainfall and the vegetation covering the watershed, the ordinary flow of this and other east Texas streams is much more uniform than that of the streams farther west.

Below are the results of discharge measurements at the gaging station established near Longview by Professor Taylor, of the Hydrographic Division of the U. S. Geological Survey.[a]

Estimated discharge of Sabine River near Longview, Tex.

[Drainage area, 2,900 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1904	6,544	36	811	585,600
1905	19,480	122	4,290	3,138,000
1906	13,200	74	2,270	1,630,000

For the year 1904 the minimum discharges for the months of August, September, October, November, and December were 44, 44, 36, 53, and 44 cubic feet per second, respectively, and the corresponding maximum discharges for the same months were 580, 426, 63, 109, and 869 cubic feet per second. The greatest discharge occurred during April, when the maximum was 6,544 cubic feet per second, while the minimum was 620 cubic feet per second.

For 1905 the minimum discharges for the months of August, September, October, November, and December were 162, 135, 122, 483, and 660 cubic feet per second, respectively, while the maximum discharges for the same times were 7,316, 326, 1,461, 2,907, and 17,360 cubic feet per second, respectively. The maximum for the year occurred in May, and was 19,480 cubic feet per second, while the minimum for that month was 9,735 cubic feet.

NECHES RIVER.

The Neches River heads in Van Zandt County, flows southeasterly through the heavily wooded portion of east Texas, and empties into Sabine Lake 18 or 20 miles above Port Arthur. The drainage area above Evadale, at which point the U. S. Geological Survey maintains a gaging station, is 8,200 square miles. For the last half of 1904 the minimum discharge of 202 cubic feet per second occurred in November and the maximum of 7,590 cubic feet occurred in December. The total discharge for the six months was 239,200 acre-feet.[b]

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 99 and 174.

[b] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 99, 174, and 210.

Estimated discharge of the Neches River at Evadale, Tex.

[Drainage area, 8,200 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1905	18,300	484	7,059	5,114,000
1906	12,300	560	3,920	2,830,000

The minimum for the yea. 1904 (484 cubic feet per second) occurred in October and the maximum (18,300 cubic feet per second) occurred in May, with March, April, June, and July running high also.

The principal tributary of the Neches is Angelina River, which unites with the Neches a few miles below Rockland. There are a number of small water-power plants on the Neches and its tributaries, utilizing water under heads varying from 4 to 32 feet. In Jefferson County, particularly, the water from this stream is extensively utilized in rice irrigation. The total length of the Neches River is approximately 300 miles.

TRINITY RIVER.

The Trinity heads in Montgomery, Wise, Jack, and other counties which lie close to the Red River, on the northern boundary of the State, and flows southeasterly for 600 or 700 miles to its outlet, in Galveston Bay. Its length above Dallas does not greatly exceed 150 miles, and ordinarily the flow at that point is quite low, sometimes practically ceasing. During the spring of 1908 torrential rains on the watershed above Dallas caused severe damage by floods in the lower portion of the city.

There are a few small power plants in the watershed of the Trinity, which utilize heads ranging from 8 to 22 feet, but the power developed is low. On the lower portions of the stream rice irrigation is practiced, and a much larger use of the water for this purpose and for the irrigation of other crops, such as sugar cane, alfalfa, etc., is possible by pumping. Some years ago an examination was made of a site for a reservoir near Shepherd, where it is possible to utilize the water from one of the small tributaries of the river. Impounding reservoirs may be located in many places on the upper reaches of the stream.

A system of locks and dams is now being installed by the United States Government with a view to making the stream navigable for small boats for a portion of the year from the mouth of the stream to Dallas. While this is easily possible for the lower portions of the river, the small discharge on the upper portion will make it difficult during the season of small flow. For several years a gaging station was maintained at Dallas by the U. S. Geological Survey, but was

finally abandoned because of the small discharge. Beginning with the year 1903, the Survey has maintained a gaging station at Riverside, Tex., the summary of results of measurements, so far as available, being given below:

Estimated discharge of Trinity River at Riverside, Tex.[a]

[Drainage area, 16,000 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1903	27,270	225	6,897	4,983,895
1904	17,610	160	2,936	2,124,000
1905	38,500	360	10,770	7,835,000
1906	22,900	386	7,200	5,200,000

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 99, 171, and 210.

BRAZOS RIVER.

The Brazos is the longest river in Texas and discharges the most water. Its total drainage area is equal to the area of the State of Pennsylvania. Its headwaters originate in the Llano Estacado (Staked Plains), with possibly some intermittent drainage from eastern New Mexico. The general trend is southeasterly. Its principal branches are Double Mountain and South Forks, which unite in Stonewall County; Clear Fork, which joins the main channel in Young County; Little River, the mouth of which is in Milam County; and the Navasota River, which joins the main stream in Grimes County. There are a number of smaller tributaries, such as the Little Brazos and the Yegua, which contribute considerable quantities of water after heavy rainfalls.

The U. S. Geological Survey maintains gaging stations at Waco and Richmond, and for three years (1900–1902) measurements were carried on for this Office at Jones Bridge, Brazos County, and at Richmond during the summers of 1901 and 1902. The results of these measurements, as far as they are now attainable, are given in the table below:

Estimated discharge of Brazos River at Waco, Tex.[a]

[Drainage area, 30,800 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1899	77,076	26	3,025	2,191,255
1900	98,832	315	5,755	4,151,940
1901	38,017	61	836	605,241
1902	74,600	20	2,694	1,968,668
1903	65,000	90	1,360	1,434,842
1904	17,180	72	1,180	858,500
1905	85,500	184	3,775	2,754,000
1906	40,900	284	2,350	1,700,000

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 75, 84, 99, 132, 174, and 210.

Discharge of Brazos River at Jones Bridge, Tex.[a]

[Drainage area, 37,400 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1900	135,000	1,020	12,021	8,706,796
1901	19,392	246	1,349	976,602
1902	65,934	213	4,645	3,362,991

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 104, 119, 133.

A gaging station was established at Richmond, Tex., by the U. S. Geological Survey in December, 1902, and for this station the following results are available:

Estimated discharge of the Brazos River at Richmond, Tex.[a]

[Drainage area, 44,000 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1903	66,550	945	8,601	6,213,080
1904	47,590	820	3,377	2,461,000
1905	65,590	1,160	12,490	9,098,000
1906 [b]	37,300	1,290	....	1,660,000

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 99, 132, 174, and 210.
[b] January to June, inclusive.

During the irrigation seasons of 1901 and 1902 a gaging station was maintained for this Office at Richmond, and the following mean daily discharges were obtained for 1901: July, 1,080; August, 966; September, 1,304; and October, 1,104 cubic feet per second. The minimum discharge found in 1901 was 710 cubic feet per second. For the year 1902 the mean daily discharges were: June, 3,640; July, 6,787; August, 25,720; and September, 3,660 cubic feet per second.

The foregoing results show wide variations at all stations for various years, the run-off depending not only upon the amount of rainfall, but upon its distribution. The years 1901 and 1904 were years of small rainfall and the run-off shows the results of this very plainly. It will be noticed that the discharges at Richmond are three or four times as great as the corresponding discharges at Waco. This is due to the run-off contributed by tributary streams which enter below Waco.

At certain stages the Brazos River carries large quantities of sediment, the bulk of which appears from its red color to be derived from the Permian formation on the upper portions of the watershed.

Summary of silt measurements, Brazos River, Tex.[a]

[Collections made at Jones Bridge.]

Time.	Total discharge.	Silt—one week's settlement.		Silt—one year's settlement.	
	Acre-feet.	*Acre-feet.*	*Per cent.*	*Acre-feet.*	*Per cent.*
August 1 to December 31, 1899	1,165,300	10,090	0.866	7,567	0.649
January 1 to December 31, 1900	8,806,986	115,782	1.315	86,837	.986
January 1 to December 31, 1901	976,602	12,838	1.262	9,246	.947
January 1 to December 31, 1902	3,362,991	40,190	1.195	30,142	.896
Total for 41 months	14,311,879	178,900	1.246	133,792	.935

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 133, p. 205.

During 1902 the collections were made at much shorter intervals than for the time preceding, but the results are only a little smaller than for the entire period. Probably a mean value of 1.2 per cent by volume for one week's settlement and 0.9 per cent for one year's settlement would be not far wrong as an estimate of general conditions. The percentages of silt were determined volumetrically, and are much larger than similar determinations based on weights where the weight of a given volume of the sediment has been assumed.

In the projection of storage reservoirs on this stream the effect of such large quantities of sediment should be carefully considered. From the vicinity of Waco to its mouth, a distance of perhaps 300 miles, the Brazos River bottom-lands are subject to overflow, and in the slack waters heavy deposits of silt are often formed. The overflows of 1908 have caused several projects for building levees along portions of the stream to be talked of, but nothing definite has been accomplished.

It does not seem probable that extensive storage reservoirs will be attempted on the lower stretches of this river, because of the generally unstable character of the bottom and banks of the river, although it is possible to construct dams on stable foundations at a few points, such as the rock falls below Marlin. Any such reservoir would have its storage capacity reduced materially in time by the deposit of silt, as was the case with the Austin dam across the Colorado River. On the upper portions of the watershed on the various tributaries, such as Clear and Salt forks, impounding reservoirs are possible and something of the kind has been projected. There are several small wood and brush dams also which have been built for power development on the Clear Fork, Leon, Bosque, Lampasas, Salado, San Gabriel, and Navasota rivers, all tributaries of the Brazos, but as yet the power developed is low, probably not exceeding 50 horsepower for any one plant.[a]

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 105.

A system of locks and dams is being constructed on this river with a view to making it navigable for small craft from Waco to its mouth during certain seasons of the year.

In Fort Bend and Brazoria counties considerable water is now being pumped from the Brazos for rice irrigation, but opportunities still exist for large development along this and other lines in these counties.

WICHITA RIVER.

The Wichita heads in King and Cottle counties and has a general eastward trend for its whole length of about 150 miles. It empties into Red River about 20 or 25 miles northeast of Wichita Falls. In Knox and Baylor counties the Wichita and the Salt Fork of the Brazos approach within a few miles of each other, and it was proposed some years ago that a dam be constructed across the latter river to divert a large portion of its waters through a canal on to the watershed of the Wichita, but this plan has not been carried out. A gaging station was established for this Office at Wichita Falls in 1899, and the results of all consecutive discharge measurements are given below:

Discharge of Wichita River at Wichita Falls, Tex.[a]

[Drainage area, 3,050 square miles.]

Time.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
February 10 to December 31, 1900	16,400	51	1,307	842,453
January 1 to December 31, 1901	72,620	4	410	297,883
January 1 to February 15, 1902	6	4	4.8	436

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 104 and 119.

During 1900 the maximum discharge occurred during the latter part of July, while in 1901 it occurred during the latter part of May. The minimum in 1900 occurred in December, and in the same month in 1901. The total discharge during the latter year, however, was only a little more than one-third that of the preceding year.

The foregoing measurements were made with a view of ascertaining whether or not there was sufficient discharge to properly maintain a projected irrigation system on this river, the storage reservoir for which was to have been located perhaps 40 miles above Wichita Falls, and was designed to impound about 200,000 acre-feet.

Measurements of the quantity of silt carried by the waters of this stream were also made. For the period from February 10 to December 31, 1900, 10,172 acre-feet of silt was carried down, as determined volumetrically after one week's settlement. This corresponds to a percentage of 1.207 for one week, or approximately 0.906 per cent after one year's settlement. For the year 1901 about

4,640 acre-feet or 1.557 per cent at one week's settlement was obtained, which equals 1.168 per cent, approximately, for one year's settlement. The foregoing results clearly indicate that the effect of silt upon the storage capacity of a reservoir situated on this stream should not be left out of consideration.

The soil along the Wichita River is very rich and produces excellent crops during favorable seasons. Irrigation as a supplement to the normal rainfall of about 25 inches should render it as productive as could be desired. During the spring of 1901 a reservoir of about 13,000 acre-feet capacity, and covering about 1,500 acres, was constructed on Holliday Creek, about 4 miles south of Wichita Falls, but the results of this experiment are not available.

COLORADO RIVER.

The Colorado River rises in Gaines and Colorado counties, with possibly some contributary drainage area in southeastern New Mexico. Its drainage area is not very much smaller than that of the Brazos, but owing to smaller general rainfall on much of its watershed the total run-off is considerably less. The following tables give the results of discharge measurements on this stream, as far as they are available:

Estimated discharge of Colorado River at Austin and Columbus, Tex.[a]

AUSTIN.

[Drainage area, 37,000 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1896	14,100	180	1,460	
1897	11,000	200	1,200	
1898	29,000	210	1,880	
1899	103,400	180	1,170	
1900	123,000	410	3,115	
1901	40,912	175	1,994	1,350,557
1902	31,250	180	2,224	1,619,108
1903	33,070	320	1,300	1,550,434
1904	46,140	200	1,595	1,154,000
1905	51,190	175	1,918	1,360,000
1906	70,300	175	3,060	2,230,000

COLUMBUS.

[Drainage area, 40,000 square miles.]

1904	28,900	390	2,225	1,517,000
1905	37,900	680	3,358	2,444,000
1906	38,000	880	2,730	1,980,000

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 84, 99, 105, 132, 174, and 210.

During the rice-irrigation seasons of 1901 and 1902 a gaging station was maintained at Wharton for this Office, where the mean daily discharges for the last half of June and the months of July, August,

September, and October were found to be in 1901, 1,018, 1,835, 816, 1,818, and 810 cubic feet per second, respectively. For the months of June, July, August, and September, 1902, the mean daily discharges were 1,369, 3,921, 7,531, and 3,070 cubic feet per second, respectively.[a]

The minimum discharge of 459 cubic feet per second in 1901 occurred on July 9, and during the first fifteen days of that month the mean daily discharge averaged only about 550 cubic feet per second. During the latter half of August it was not very much greater. On June 28, 1902, the minimum discharge occurred, amounting to only 405 cubic feet per second, but the mean for the month was 1,368 cubic feet per second. The maximum for this season occurred on August 3, and amounted to 41,563 cubic feet per second. Altogether, much more water passed down during 1902 than during 1901.

Rice irrigation along the Colorado has been highly developed both above and below Wharton, and judging by the amount of water pumped below, it would seem probable that the discharge lower down is increased by seepage from the water-bearing strata of the locality.

Below Austin the channel of the Colorado lies in alluvial bottomlands, but above it is largely in limestone formations. Hence above Austin there are many sites where masonry dams for irrigation and water-power development could be constructed. The most favorable site is probably at Marble Falls, 40 miles above Austin, where there is a natural fall of 12 feet and in a distance of 1.25 miles a total fall of 47 feet.[b] Nearly half this fall could be utilized at comparatively little expense, and all of it without difficulty. An abundance of excellent granite may be had at Granite Mountain, 2 miles distant, on the line of the Houston and Texas Central.

The natural fall is now being utilized in pumping water for Marble Falls, and the minimum recorded flow is 160 cubic feet per second. The flow of the river is to be utilized by a manufacturing company, which is constructing a dam 18 feet high on the crest of the falls at a cost of about $300,000 and by which the engineer estimates that 1,000 to 1,200 horsepower will be developed under 30-foot head.

Many excellent sites for dams exist still higher up the river and on its tributaries, and a few have been built, such as those at Kingsland and Bluffton. Austin dam, of which the construction, power house, water mains, street lighting, etc., cost $1,600,000, is situated just above Austin at the mouth of the canyon-like channel through the limestone formation. This dam was completed in 1891 and was broken by a severe flood in April, 1900. At Columbus, 75 or 100

---

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. Nos. 119 and 133.

[b] U. S. Geol. Survey, Water-Supply and Irrig. Papers No. 105.

miles above the mouth of the river, a power plant has been suggested and surveys made for same, but the alluvial banks of the river present difficulties here, as is the case for the lower reaches of all Texas streams.

The Pedernales, Llano, and San Saba rivers, Pecan Bayou, and the Concho River are the principal tributaries, of which the Llano and the Concho carry most of the water. Numerous small dams have been built on these streams for power and irrigation purposes, of which the most important now in operation is the stone and concrete dam at San Angelo, Tom Green County.

There are several small dams on the Concho which are utilized in diverting water for irrigation and some for generating a small amount of power; also on the tributaries of these streams and the San Saba, the latter of which has a reliable, though small flow. There are excellent opportunities for constructing impounding reservoirs. The Llano River affords excellent sites for dams and reservoirs, and there are a number of small power plants along its source, as at Junction and Llano. At the latter place waterworks, an electric-light plant, and power for commercial purposes are operated by water power developed by means of a small dam across the stream.

GUADALUPE RIVER.

The Guadalupe River heads in Kerr County, 75 or 100 miles northwest of San Antonio, and empties into San Antonio Bay. Its total length is approximately 300 miles. Its principal tributaries are the San Marcos and Comal rivers. The latter is quite short, but furnishes considerable water derived from springs which issue from fissures in the rocks at the edge of the Edwards Plateau. The San Marcos also has its origin in similar springs near the town of the same name, about 50 miles east of San Antonio.

While the discharge of the Guadalupe in the vicinity of New Braunfels (32 miles east of San Antonio) has been found to be as small as 13 cubic feet per second the lowest recorded discharge of the Comal at New Braunfels is 310 cubic feet per second, while that of the San Marcos at the town of the same name was 89 cubic feet per second.[a]

The United States Geological Survey maintains a gaging station on the Guadalupe, near Cuero, from the records of which the following results are taken.[b]

---

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 105.

[b] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 99, 132, 174, and 210.

Estimated discharge of the Guadalupe River near Cuero, Tex.

[Drainage area, 5,100 square miles.]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1903	71,300	755	2,487	1,798,056
1904	6,886	465	819	595,300
1905	10,580	545	1,318	935,700
1906	4,650	370	643	464,000

While the drainage area above Cuero is only 5,110 square miles, the Guadalupe is perhaps the best power stream in the State. This is due to the volume of water supplied by the springs which form the Comal and San Marcos rivers. In the vicinity of New Braunfels the available water power has been quite freely used, several hundred horsepower being developed there for electric lighting and manufacturing purposes. Above New Braunfels are several small power plants, and there are similar ones below. In the neighborhood of Seguin are several plants, which together are capable of developing several hundred horsepower, as is the case for plants at Gonzales and in the vicinity of Cuero. On the San Marcos River, at and below the town, are more than a dozen small power plants, which together develop several hundred horsepower under low heads. One at San Marcos furnishes water to the town, another yields power for electric lights, while a third is utilized in manufacturing ice.

By increasing the heads and developing new sites the water power of the Guadalupe and its tributaries may be greatly increased, and by reason of the comparative proximity of San Antonio, Austin, and a number of small towns it would seem that at some future time the development of power for electric transmission would prove an attractive proposition.

SAN ANTONIO RIVER.

The San Antonio River proper rises 3 miles north of the center of the city of San Antonio and is fed almost entirely by springs, though it has considerable contributary drainage area on the northwest by way of the Medina River and on the east by Cibolo Creek, the former joining the main stream 12 or 15 miles below the city of San Antonio, while the latter enters in Karnes County, about 50 miles below the city. In San Antonio and vicinity are many artesian wells, which evidently derive water from the same stratum which supplies the springs, for these wells have materially affected the discharge of the springs at times, and both show a marked diminution of flow during prolonged dry spells. Some of the artesian wells are utilized for the water supply for the city waterworks, while others in the outlying districts furnish water for irrigation.

There are several power plants in San Antonio, but the variability of flow of late years has made it necessary to install auxiliary steam plants at some of these. Prof. T. U. Taylor found the discharge of the river as low as 9 cubic feet per second at the hot wells below San Antonio in March, 1898, and as high as 125 cubic feet per second at the same point in September, 1900, since which time measurements have shown discharges varying between 41 and 117 cubic feet per second, the latter measurement having been made in September, 1905.[a] Evidently the heavy rainfall of 1899 and 1900 was responsible for the increase.

From the upper power house in San Antonio to a point a short distance below the city the total fall is in excess of 100 feet, and it would seem possible to further develop the production of power. It is possible also that the use of water for irrigation in the vicinity may be extended, though some of these systems are reported to command as much as 500 acres at the present time. From the city of San Antonio to the junction of the San Antonio and Guadalupe rivers, a few miles above the point where they enter San Antonio Bay, the distance is perhaps 115 miles on an air line.

NUECES RIVER.

The drainage of the Nueces River begins in Edward County, and the stream has a general southeasterly trend for nearly 300 miles to its outlet in Corpus Christi Bay. Its principal tributary is the Frio River, which joins the Nueces near the town of Oakville. The upper portion of this stream is fed by springs and there is a nearly constant flow which is partly used for irrigation. For a distance of a few miles near the Southern Pacific Railway crossing west of Uvalde the flow disappears in the gravel bottom, but reappears farther down. Springs add to the discharge of this river on the lower portion, increasing it materially.

Near Cotulla there are several irrigation plants which pump against an average head of 30 feet and water several hundred acres, planted chiefly to Bermuda onions. One of these plants operates successfully against a head of 45 feet.

DEVILS RIVER.

Devils River, less than 100 miles long, has a watershed which begins in Sutton and Crockett counties, and it empties into the Rio Grande 12 or 15 miles northwest of Del Rio. Its real source, however, is in Pecan Springs, about 50 miles above its mouth. The following results of discharge and gage-height measurements are available.

---

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 174.

Estimated discharge of Devils River at Devils River, Tex.[a]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1901	840	480	627	453,421
1902	5,380	380	491	355,219
1903	10,400	380	587	415,137
1904	1,580	410	520	377,652
1905	6,470	425	667	482,977
1906	30,000	350	837	609,797

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 174 and 210.

The foregoing summary is the result of measurements made by the International (Water) Boundary Commission.

The water in Devils River is clear and sparkling and could be utilized for irrigation in the vicinity of Del Rio. Just east of Del Rio, San Felipe Creek rises from springs and furnishes water for extensive irrigation and for power purposes. From a number of discharge measurements made on this stream by Professor Taylor for the years 1895 to 1905 the minimum discharge was 99 cubic feet per second in 1895. The next smallest was 103 cubic feet per second in 1905. The creek empties directly into the Rio Grande a few miles below Del Rio.

PECOS RIVER.

This river rises far up in the mountains of New Mexico, but from the point where it enters Texas on the boundary line between Loving and Reeves counties to the point where it empties into the Rio Grande, about 40 miles northwest of Del Rio, its length is upward of 250 miles. Large irrigation systems in the vicinity of Barstow and Grand Falls successfully utilize the water from this river, notwithstanding it is highly impregnated with alkali. Some little use of the water for power purposes has also been made at Barstow and Grand Falls, and this use may be extended.

Nearly 100 miles above its mouth the river enters a gradually deepening canyon, and at Viaduct, the Southern Pacific Railway crossing, the top of the rail is 321 feet above low-water level. The rocky walls and bottom of the canyon afford excellent opportunities for the construction of dams for storage reservoirs, but so far the water has not been utilized here, either for power generation or for irrigation.

The following table shows the summary of results of measurements on the Pecos River near Moorehead, close to the high bridge of the Southern Pacific at Viaduct.

Estimated discharge of the Pecos River at Moorehead, Tex.[a]

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1901	9,200	160	633	457,249
1902	11,100	210	578	419,107
1903	2,140	170	408	294,318
1904	17,500	110	861	623,922
1905	14,570	470	1,246	904,880
1906	35,570	415	920	669,094

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 75, 84, 99, 132, 174, and 210.

RIO GRANDE.

Lying west of the Pecos is an area of approximately 32,000 square miles in Texas which is practically unwatered, except for a few creeks leading into the Pecos on the east and similar ones into the Rio Grande on the west. The annual rainfall in this trans-Pecos region is small, but the rate of precipitation is frequently great, which, combined with the steep slopes of the mountain sides, converts the otherwise dry arroyos into raging torrents at times. The springs near Toyah furnish water for the irrigation of hundreds of acres, and in the vicinity of El Paso lands on both sides of the river are irrigated by water diverted from the Rio Grande when there is water flowing in the channel. Irrigation systems higher up have absorbed most of the ordinary flow of this river, and as a consequence irrigation is practiced on a much smaller scale than formerly. In Presidio and Brewster counties irrigation from springs is practiced to some extent.

Near Eagle Pass irrigation is practiced to a considerable extent, water being pumped from the Rio Grande for this purpose and utilized in growing onions and garden truck. Also near Laredo large areas are planted to onions, etc., and watered by pumping from the Rio Grande.

In the vicinity of Hidalgo there are large areas of irrigated alfalfa, sugar cane, sorghum, corn, onions, etc., for which the Rio Grande furnishes the necessary water. From Hidalgo on down the river extensive irrigation plants have been constructed during the last few years or are now in process of building, where sugar cane, alfalfa, truck crops, melons, etc., are extensively cultivated and will soon be grown on a much larger scale.

Omitting the smaller sinuosities of the stream, which are very pronounced for the entire length of the river, especially in the alluvial bottoms, the Rio Grande forms the boundary between Mexico and Texas for about 900 miles. For a large part of this distance it flows through picturesque rock canyons.

Below are given results for a few points on the Rio Grande, the discharges having been determined by the International (Water) Boundary Commission:

Estimated discharge of the Rio Grande near El Paso, below Presidio, and near Eagle Pass, Tex.[a]

[Drainage area, 30,000 square miles.]

NEAR EL PASO.

Year.	Maximum.	Minimum.	Mean.	Total.
	Cu. ft. per sec.	*Cu. ft. per sec.*	*Cu. ft. per sec.*	*Acre-feet.*
1901	3,980	0	499	363,968
1902	2,140	0	70	50,768
1903	18,070	0	1,429	1,032,844
1904	17,100	0	643	472,781
1905	23,680	15	2,782	2,011,794
1906	8,700	10	1,533	1,113,968
BELOW PRESIDIO.				
1901	5,690	20	778	564,732
1902	45,000	10	2,109	1,532,420
1903	8,960	105	1,441	1,043,563
1904	149,200	5	3,573	2,579,703
1905	27,170	720	5,380	3,905,411
1906	37,400	670	5,141	3,734,164
NEAR EAGLE PASS.				
1901	21,460	1,600	3,176	2,298,763
1902	32,000	1,260	3,831	2,778,487
1903	47,400	1,640	4,010	2,904,179
1904	172,300	1,250	7,381	5,336,270
1905	238,300	3,130	11,164	8,102,400
1906	178,650	2,010	10,490	7,634,122

[a] U. S. Geol. Survey, Water-Supply and Irrig. Papers Nos. 75, 84, 99, 132, and 174.

In addition to the above points, at which consecutive measurements have been made by the International (Water) Boundary Commission, similar records have been kept for a number of other points on the river, the results for which and also detailed reports for the points named may be found in the Water-Supply and Irrigation Papers of the U. S. Geological Survey. It will be noticed that at El Paso the river is frequently dry and that the discharge increases materially farther down the river, due to the entrance of tributary streams.

SPRINGS AND WELLS.

In addition to springs, such as Toyah, which are already being used for irrigation, there are a number of others in the mountainous portions of Texas which may be developed for the purpose. Artesian wells at Waco, San Antonio, Kingsville, Carrizo Springs, and other places are now used for city water supplies and some use is made of them also for irrigation. There are many small flowing wells scattered through the Brazos bottoms, but these are used mainly for

domestic purposes and for stock water. In the coast country, at Katy, El Campo, Edna, Victoria, Beeville, and elsewhere, shallow wells furnish large quantities of water for rice irrigation, and it is possible that similar development may be made in localities other than those where this is now known to be possible. This source of supply is capable of further development, but the supply is probably not inexhaustible, as many seem to believe.

LANDS.

Texas has a land area of 262,398 square miles, or nearly 167,936,000 acres. There is no definite data showing what proportion of this can be cultivated, but it would be a very conservative estimate to put it at one-half the total, or about 85,000,000 acres. At present less than one-third of this half is cultivated, and a large proportion of this third can be materially increased in productiveness by the use of more intensive methods, the use of fertilizers, and the aid of irrigation. Perhaps 75 per cent of that portion of the State lying below the 1,000-foot contour can be brought under cultivation as far as the character of the land is concerned, but some of this area will require artificial application of water before success can be expected. The roughest portion of the State lies in the trans-Pecos region, much of which is unfit for grazing, though some of it is mineral bearing.

Of the crops grown, cotton leads, with an acreage of 10,000,000 acres or more; corn comes next, with something like 7,000,000 acres; and mixed crops make up a large proportion of the balance. Rice covers nearly 250,000 acres, and the area under orchards, especially peaches in eastern Texas, is constantly increasing.

There are no forest reserves in the State and no reclamation work has been done so far by the Government, though the benefits of the Reclamation Act were extended to Texas by act of Congress of June 17, 1902, and the provisions of this act were formally accepted by the twenty-ninth legislature of the State, during April, 1905. There is a movement on foot to construct a canal which will serve 45,000 acres in the Texas portion of the Rio Grande Valley from the Rio Grande project of the U. S. Reclamation Service.

The last printed report of Mr. John J. Terrell, commissioner of the general land office of the State of Texas, covering the two years preceding August 31, 1906, shows that at that time there was 13,143,738 acres of surveyed public-school lands owned by the State, in addition to a considerable acreage of unsurveyed school land commonly called "public domain or scrap land." Three-fourths of this acreage is situated in the trans-Pecos region, and is not well adapted to agricultural uses because of its mountainous character and the present scarcity of available water. Mr. Terrell states in his report that the

total area of school land approximates 44,000,000 acres. Mr. W. H. P. Hunnicutt, chief draftsman of the Texas land office, on August 11, 1908, writes:

> The public free school lands controlled by the State yet unsold amount to approximately 6,500,000 acres. The average price per acre at which it is being offered is $1.50.
>
> The State University owns and controls 2,000,000 acres, but is not offering any of it for sale. I estimate the average value of that land per acre at $2.50.
>
> This office has no printed summary showing unsold land and prices. Sales are being made every day and such a summary would be impracticable.

The report of the commissioner of lands for 1906 shows that nearly 7,000,000 acres of school land had been leased to individuals for grazing purposes at that time, at prices ranging from 3 to 7 cents per acre. Practically all leased for 3 cents (4,875,434 acres) was leased prior to 1903. Much of the acreage of public land west of the Pecos is classed as mineral land and carries with its purchase a different minimum price from that borne by agricultural land. The absence of any complete topographical map of this area makes it difficult, however, to definitely state whether or not the classification in many individual instances is correct. There is still a small area of public land in eastern Texas which is classed as timber land, but very little of this now bears timber of any particular value.

Texas has no state engineer and none of the state departments is charged with the collection of data regarding the distribution of the cultivated and uncultivated acreage of arable, irrigable, forest, and waste land in detail, nor with a compilation of the areas irrigated and the unoccupied areas of good land under ditch now ready for settlement. The data given for various irrigation systems under the head of irrigation enterprises in this report contain partial answers to some of these questions, and doubtless the recently created department of agriculture for the State will be able to furnish other data later. Formerly this department was simply a branch of the department of agriculture, insurance, statistics, and history, but funds for the collection of data along the above lines have not been available in sufficient quantity to cover the field. In spite of this fact the department has issued statistical reports, the last to be printed being issued in 1905.

PRODUCTS OF IRRIGATED LANDS.

Because of the wide variation in climatic and other natural conditions it is not possible to summarize results regarding irrigated, or nonirrigated products for that matter, for the State of Texas in such a way as to give even approximately fair average results. In some localities nonirrigated crops will produce nearly if not quite as much as the same crops under irrigation in other localities. Under the

descriptions of the various irrigation enterprises will be found in some cases comparisons made by irrigators. It will be noticed that in some instances wide variations in the quantities and values of irrigated products even for the same locality exist in these descriptions.

In answer to an inquiry as to the character of crops grown, or to be grown, on the largest irrigation system in the State, Mr. W. S. Chaplin, president of the American Rio Grande Land and Irrigation Company, says "anything that grows." This is too strong a statement, perhaps, to be taken literally for any one section, but his answer comes very nearly applying to the State as a whole. Apples, for instance, would probably not flourish on the lower Rio Grande, though they do well in the vicinity of Denison and elsewhere in the northern portion of the State.

The list of products which can be grown successfully is rapidly being extended, and many which a short time ago were considered entirely foreign to the State are found to flourish, especially under irrigation. Some semitropical fruits and vegetables do well in the lower coast country, and oranges, grapefruit, dates, olives, bananas, kumquats, tangerines, etc., have been tried with some success. Tea growing has been experimented with in one locality by the U. S. Department of Agriculture, but the experiment has been abandoned. This does not prove, however, that it can not be made a success in some other portions of the State. Near Wharton the Department is now experimenting with camphor, and in one place at least in the trans-Pecos region a factory is in operation which is producing commercial rubber from the guayule shrub. On the lower Rio Grande the hennequin fiber plant is being cultivated for rope-making purposes, the fiber being of unusual length and strength. In the Pecos Valley European grapes are being tried and when grafted on native resistant stock are found to do exceptionally well. Formerly large quantities of the Mission grapes were grown in the El Paso Valley, but on account of the scarcity of water since the heavy drains made upon the Rio Grande higher up the river, large vineyards have been abandoned. Possibly, however, they may be cultivated again after the Rio Grande project of the Reclamation Service shall have been completed.

In certain portions of east Texas, as at Willis and Nacogdoches, it has been demonstrated that a fine grade of tobacco can be grown. The Galveston News of August 16, 1908, puts Texas third in point of value per acre of tobacco crop. Florida leads with $416.25 an acre; Georgia follows with $344; and Texas third, with $210 per acre. Twenty-two other States fall below this, and the average assigned for the whole United States is $86.75. In tobacco culture, as in many other agricultural lines, Texas is but a beginner, ranking

twentieth among the States in production and twenty-first in acreage; but more encouraging results are to be expected as experience is gained.

As illustrating the difficulty of comparing irrigated and nonirrigated products, it is stated on the best authority that in the San Angelo country nonirrigated cotton generally yields one-fourth to one-half bale per acre, but under irrigation 1 to 1½ bales per acre is common. On the lower Brazos and Colorado bottom lands 1 bale and sometimes 2 bales per acre were not uncommon before the advent of the boll weevil, without the least attempt at irrigation. In Grayson County, in the vicinity of Sherman, Mr. R. E. Smith, who is entirely dependent upon natural rainfall, raises large quantities of alfalfa with almost as large a yield per acre as can be gotten in some other localities under irrigation.

The people of the State are awakening to the value of diversification, and to a large extent the "one-crop" plan is already giving place to variation in the character of the agricultural products. The benefits are easily seen in the increased prosperity and the increasing number of small farmers who are beginning to learn that it pays to raise many things for home consumption for which a market has not yet been established. In many localities the difficulty of getting products to market has so far limited the variety of perishable products which can be successfully grown, but increasing transportation facilities and increasing growth of comparatively near-by cities are rapidly tending to minimize this difficulty.

HISTORY OF IRRIGATION DEVELOPMENT.

The beginning of irrigation in western Texas antedates any records so far found, and it is probable that in no portion of the United States is the practice older. Scanty and irregular distribution of rainfall was doubtless the cause of its use in the beginning, and even at later dates, when unnumbered acres of fertile lands could be had for little more than the trouble of preparing them for cultivation. Coronado, on his journey northward in the early part of the sixteenth century, found well-established systems of irrigation in the vicinity of El Paso, utilizing water from the Rio Grande on both sides of its present channel.

Tradition tells us that the Pueblo Indians of Ysleta claimed that ancient irrigation systems of great extent were built centuries ago by the Yuma Indians on the Pecos River in the vicinity of Pecos and Grand Falls, but the constant raids by the Comanche and Apache Indians caused them to move on to the valley of the Rio Grande, only to be followed there by their old enemies and forced to move out to the Colorado of the West. In the vicinity of Toyah Springs

evidence is found indicating that these waters were used for irrigation purposes long before the first white man found his way there.

At San Antonio, when the Franciscan fathers founded their missions they directed the construction of canals or acequias by the Indians. These canals were used not only for supplying water to the missions for domestic purposes, but for irrigation as well. Among the ditches constructed between the years 1716 and 1774 may be mentioned the Concepcion, Alamo, San Jose, San Juan, and Espada.[a] In 1730 the San Pedro ditch was built by immigrants from the Canary Islands and was used for conducting water to the cultivated fields.[a]

At old Fort San Saba, near Menardville, the remains of an irrigation system, constructed in 1774, also by the Franciscan fathers, can still be traced.[a]

As early as 1852 the fourth legislature passed an act relative to irrigation. In 1882 the seventeenth legislature passed an act making large grants of land for the construction of irrigation ditches. There were several classes and the number of sections of land granted per mile of ditch varied with the class. In 1889 and in 1895 additional regulations were established with a view to encouraging irrigation. The result of some of these enactments was the projection of numberless irrigation schemes, many of which were "boom" propositions from the start, while others proved failures when constructed because of the lack of sufficient hydrographic and other data.

Irrigation along the lines now practiced began to develop first in western Texas. The first ditch in the vicinity of Del Rio was constructed in 1868, another in 1869, and another in 1874. On the Pecos, one of the present large systems was built in 1875, another in 1887, and another in 1896. It might have been expected that the older systems in the vicinity of El Paso would have suggested earlier extensions under present methods, but work of this character did not become active until about 1889 to 1891. At Fort Stockton and for the Nueces drainage area it began as early as 1876. On the Concho, San Saba, Llano, and other tributaries of the Colorado River irrigation systems began to spring up about 1875, and possibly earlier, and these were added to about 1879, but this work became most active in the nineties.[b]

Along the lower Rio Grande not a great deal appears to have been done on a large scale until about 1896, but since that time irrigation development in this section has been extremely rapid, especially during the last few years.

At San Antonio the Upper Labor ditch was built about 1776 and served a large acreage; the Concepcion was built in 1729 and served

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 71.

[b] Data derived principally from U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 71.

continuously until 1869, when it was abandoned. The Espada, built by the Spanish in 1824, was abandoned about 1880 or 1885, but was revived in 1895.[a] In the vicinity of San Antonio irrigation from artesian wells began about 1884 and was extended rapidly during the nineties. These wells are of various depths, some being in the neighborhood of 1,500 feet. At Waco a flowing well, 1,850 feet deep, was put in operation for irrigation purposes in 1896.[a]

In eastern Texas, where the rainfall not infrequently exceeds 50 inches per annum, one would not normally expect to see irrigation practiced on a large scale, but the reverse is the case. A clipping from some journal, the name of which was not ascertained, gave in very few words an explanation of the reason for this condition. The following is a copy of the clipping:

History of Texas rice industry in brief.

Brought to Texas by first settlers.
110 acres in cultivation in 1850.
135 acres in cultivation in 1890.
8,711 acres in cultivation in 1900.
250,000 acres in cultivation in 1908.
8,206 acres in cultivation in Orange and Jefferson counties in 1900.
75,000 acres in cultivation in same counties in 1908.
Jefferson County produces one-eighth of rice harvest of this country.
200 miles of canals in Jefferson County. Five largest rice mills in the world.
Annual value of crop to Jefferson County, $2,000,000.
$700,000 invested in mills.
$4,000,000 invested in rice production.

Neither time nor opportunity admits of the verification of the above figures in detail, but the total acreage stated for 1908 is a little above the estimate of Mr. A. E. Groves, secretary-treasurer and manager Texas Rice Farmers' Association and Exchange, of Houston, which placed it at about 225,000 acres. In point of money invested and in extent of area covered, rice irrigation exceeds any other class of irrigation in the State, and possibly all of the others combined.

The methods employed in Louisiana and Texas differ radically from the older methods in use in South Carolina and Georgia, where periodic variations of the water level in tidal rivers make it possible to flood the lands or drain them through the same channels by merely opening gates or "trunks" at the proper stages of the water in the rivers. In Louisiana and Texas pumping, often against high heads, had to be resorted to, but the differences possible in the methods of preparing the land and in harvesting the crop demonstrated that the methods could be made to pay. Following the lead of Jefferson County in the early nineties, the cultivation of rice spread rapidly southwestward. About 1899 Eagle Lake, near the town of the same

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 71.

name, was first drawn on for rice irrigation and the practice spread rapidly down the Colorado River, until now the acreage in rice below Eagle Lake approximates and may exceed 50,000 acres. Later still, the Brownsville section began to be developed and has made more rapid progress in irrigation than any of its predecessors, developing the cultivation of rice, fruits, truck, and all sorts of staple products. Its future possibilities are as yet indeterminate.

Coming a little later than the first large canal system, and developing at perhaps a faster rate, shallow wells have been employed as a source of water supply. Their use has been confined largely to rice irrigation. These have increased materially the area available for irrigation, by taking in lands lying between the larger streams and more or less out of reach of many of them, and they have extended the field much farther inland upon higher topographic lines.

Along the Coastal Plain, particularly near Alvin, Beeville, and in the Brownsville region, attempts have been made to raise citrus and other semitropical fruits, which a very few years ago was not thought possible. Oranges, grapefruit, kumquats, tangerines, olives, dates, and figs are grown to some extent in the coast country, with and without irrigation, and further experiments will undoubtedly add other fruits. Irrigation has done its full share and will do more in the future to help in this line, not only in the coast country but in other portions of the State.

The area of Texas is so great that the field of existing developments has been barely touched upon, and it would require the careful, detailed study of each section to even approximate a reasonably correct statement of existing conditions. The published data available, while valuable, is not up to date, and busy men find it hard to take the time necessary to answer questions sent them by mail. Moreover, much of the work which has been done has not been recorded in available form even by the larger canal companies, so that it would require much time and patience to determine costs of existing systems where fairly well appointed offices are maintained. For the smaller systems and private enterprises it is even more difficult to arrive at correct values. Mr. C. B. Metcalfe, of San Angelo, evidently at the cost of considerable time and with the aid of an intimate knowledge of existing conditions in his section, has sent in a list of 83 irrigators in his section, who irrigate 5 to 700 acres each. Without this list less than 20 per cent of the names even could have been obtained. This will serve to illustrate the difficulty of approximating the present status of irrigation in Texas, much less to venture a guess at what the future may show.

IRRIGATION ENTERPRISES.

Considerable published data can be found relating to irrigation in Texas, but in some sections of the State material changes have been made in many of the plants since these descriptions were written. For this reason and because of a lack of space, the detailed descriptions in this report will be confined to those cases where the data were obtained directly from the owner or some officer of the company in the case of chartered organizations, or from someone who is conversant with the system and who is competent to give a correct description. For convenience, the State has been divided into arbitrary groups or divisions, as follows:

Group I.—That part devoted principally to rice culture. The area covered extends from the Sabine River to the Guadalupe River along the coastal region and as far inland as information could be obtained to the effect that rice was grown.

Group II.—All the coastal area from Beeville to Brownsville, covering the various systems on the lower Rio Grande and intervening territory.

Group III.—The area lying in the vicinities of San Marcos, New Braunfels, San Antonio, Seguin, Batesville, Laredo, Eagle Pass, and Del Rio.

Group IV.—The area in the vicinity of Wichita Falls and to the northwest of that point.

Group V.—The several small plants which cover the regions about Llano, Junction, Menardville, San Saba, Lampasas, Brownwood, San Angelo, and Abilene.

Group VI.—The Pecos Valley, Toyah, and Fort Stockton districts.

Group VII.—The Rio Grande Valley in the vicinity of El Paso and as far down as Presidio and Brewster counties.

GROUP I.

Because of the magnitude of the area covered by irrigated rice farms, the amount of money invested, and total annual returns, this group has been placed first. The following descriptive notes cover only those systems for which recent data are available, though other systems of equal or greater magnitude may exist in the territory. These are included also in the tabular statement which will be found at the end of the discussion for this group.

The Adams Bayou Canal Company.—This company has its main office at Orange, Tex. It is incorporated and has $50,000 paid up capital stock. Water for the canal is drawn from Adams Bayou and Sabine River, the lift being 17 feet. A centrifugal pump, with two 30-inch double-suctions and a 36-inch delivery, with an extra

pump on each side of the impellers, is driven by a 150-horsepower slide-valve engine, for which steam is furnished by boilers having 200 horsepower capacity. The pump is rated at 50,000 gallons per minute. The cost of pumping plant, including tankage for 2,000 barrels of fuel oil, is given as $15,000, and the cost of fuel oil per season as $5,000. The daily run for one hundred days averages fourteen hours, and the annual cost per acre for water, including labor, fuel, etc., for the 4,000 acres served, amounts to $3.50.

There are 5 miles of main canal, which is 150 feet wide for 2 miles and 100 feet wide for the remaining 3 miles. The side slopes are 1½ to 1. There are about 4 miles of laterals, having side slopes of 2 to 1 and varying in width from 80 to 24 feet. Mains and laterals cost $35,000, and the annual cost of maintaining these is given as $1,500. The water is diverted to the land by means of wooden gates about 3 feet wide, set in the levees. Four thousand acres were watered in 1908, and it is expected that the same acreage will be covered in 1909, but the canal can be made to cover an additional 4,000 acres. It is estimated that the amount of water applied during the irrigation season equals 850,000 gallons per acre—equivalent to 2.53 acre-feet per acre per annum, or a depth of a little more than 30 inches—and the average rainfall amounts to only 544,000 gallons per acre during the rice growing season, or about 20 acre-inches per acre. The former figure is probably too high and the latter figure too low.

The water rent is given as 2 sacks of rice per acre and the average yield as 8 sacks, the crop being marketed at local mills and in New Orleans. The average cost of preparing the land is placed at $5 per acre and the cost of producing and marketing the crop at $10 per acre. For favorable seasons it is estimated that a net return of $8 per acre would represent a fair average.

Unimproved lands in the vicinity have increased from $5 to $30 per acre. One man, with some help during harvest time, can care for 125 acres, and it is estimated that he would need about $2,500 to make a start. It is estimated also that about 12,000 acres will be cultivated in the vicinity during 1909 and that there are 20,000 acres of rice land in Orange County uncultivated. Ultimately it will be possible to irrigate 40,000 to 50,000 acres. Under this system there is room for 100 additional farmers to raise rice and garden truck.

The Port Arthur Rice and Irrigation Company.—Water is lifted 17 feet from the Neches River by means of an 18-inch, two 24-inch, and two 36-inch pumps, with a rating of 150,000 gallons per minute. The cost of construction was about $80,000.

The main canal is 1.5 miles long and 200 feet wide, and there are 24 miles of laterals. The cost of these was about $70,000 for construction, and the annual cost of maintenance about $2,000. Head

gates and boxes are used to divert the water from the canal and the water is not measured. The water rental is 360 pounds of rice (2 sacks) per acre, and the irrigation season is said to last from May to October.

Unimproved land before irrigation was worth $5 to $10 per acre in the vicinity, but when subject to service from the irrigation canal is worth $25 to $40. The average yield is placed at 12 barrels of 162 pounds each. The crop is marketed in Port Arthur, Beaumont, Houston, and New Orleans. There were 8,650 acres in cultivation in 1908, and 12,000 acres can be brought under canal. The average cost of producing and marketing crop is placed at $20 to $25 per acre and the average value of same at $30 to $50 per acre, while the average net return is $10 to $25 per acre. Only rice is produced. One man can manage 100 acres, and the average funds and equipment are placed at $1,200 for this purpose. The opportunities for settlement are good for dozens of real farmers.

The McFadden, Wiess, and Kyle Land Company.—Water is lifted 27 feet from the Neches River at Beaumont by means of four rotary pumps, direct-connected to four 250-horsepower Corliss engines. Each pump has a rated capacity of 35,000 gallons per minute. There are 30 miles of main canals, and the cost of plant, canals, etc., was approximately $250,000.

From the laterals water is diverted through gates upon the land, and the water rental is 2 sacks of 180 pounds each per acre. The duration of the irrigation season is given as about four months. During 1908 there were 17,500 acres under rice and the area for 1909 will probably be the same, though 20,000 acres can be brought under canal.

Unimproved lands before irrigating were worth $5 per acre, but afterwards about $10, while the value of irrigated lands is about $30. The average yield is 10 sacks of 180 pounds, and this is marketed at the mills. The average cost of producing and marketing the crop is stated as $27.25, the average value as $35, and the average net return as $7.75 per acre. One man should handle 100 acres, and the average value of equipment necessary is placed at $1,000. The opportunities for settlement are good, and it is estimated that 1,000 settlers could be accommodated in the vicinity. The estimate for the probable total number of acres to be irrigated in the vicinity during 1909 is placed at 50,000, while the ultimate acreage is put at 100,000.

The Beaumont Irrigating Company.—Water is taken from Pine Island Bayou, a tributary of the Neches River. The first lift is 31 feet. Five miles south of this is a second lift of 10 feet. At the first lift are five rotary pumps and at the second lift two rotary and two centrifugal pumps. The total pumping capacity is given as 140,000

gallons per minute. Crude oil is used for fuel. The cost of construction was not obtainable.

The main canal is 150 feet wide from center to center of the levees, which are about 4 feet high, have 4-foot crown, and a side slope of 1.5 to 1. The grade is level for the first 2 miles and drops 2 feet in the next 10 miles. The main lateral, known as the "check lateral," is 14 miles long and falls 13 feet in that distance. It is 60 feet from center to center of the levees, which have 3-foot crown, side slopes of 1.5 to 1, and average 3 feet high. There are 26 miles of additional laterals, 40 feet wide from center to center of the levees. All laterals slope about 1 foot to the mile. The cost is not obtainable. The total cost of maintenance is stated as $12,000 to $15,000 per annum, but this probably includes operation of pumping plant.

The water rent is 2 sacks (4 bushels) of rough rice of 180 pounds each, and the irrigation period lasts from three to four months. The water is not measured and is distributed to the land through small laterals, and the actual flooding season varies from thirty-five to sixty days' actual pumping. About 16,000 acres of rice were planted in 1908 and the probable number for 1909 is at least as great. At least 30,000 acres can be brought under canal.

Unimproved lands before irrigating were worth about $5 to $6 per acre, and the present value of unimproved, undrained land in the vicinity is about the same. Drainage is being provided for much of the land, which enhances its value considerably. Irrigated lands are worth $20 to $35 per acre, depending upon location, railroad facilities, etc. Ten sacks of rough rice constitute an average crop. It is marketed in New Orleans, Lake Charles, Beaumont, Galveston, and Houston. The average cost of preparing land and sowing the crop is given as $4 to $5 per acre, and it costs on an average $27.25 per acre to produce and market a crop. The average value of the crop is $35 per acre, and the average net return is $7.75 per acre.

One man can cultivate 100 to 125 acres of rice, and needs for the purpose four mules, worth $600 to $800; binder, $160; drill, $75; plows, $30; drag harrow, $8 to $10; disk harrow, $30; wagon and harness, $50. If large areas are cultivated, $3,000 for a traction engine should be added. Thrashing costs from 25 to 30 cents per sack for those not owning separators. In addition to the above equipment, the beginner should have a cash balance sufficient for maintenance of self and family for one year, with a margin for emergencies. The opportunities for settlement are good, and perhaps 100 additional families could be cared for on this canal. Honest, industrious men with some money are wanted. Mr. A. C. Love, engineer for the company, estimates that there are 100,000 acres of land in Jefferson County alone which are available for rice irrigation. He also adds that there is a disposition on the part of the canal companies

owning land to cut it up into small tracts and sell on easy terms to actual farmers, one company now being engaged in making arrangements to cut up some 10,000 acres for this purpose.

The Neches Canal Company.—The Neches Canal is located in the northern portion of Jefferson County and draws water from Pine Island Bayou, a tributary of the Neches River, from which it is lifted 35 feet at the bayou, and 2 miles back from the bayou is a second lift of 10 feet. At the first lift are six rotary pumps of 35,000 gallons per minute rated capacity each, for which steam is furnished by three 900-horsepower water-tube boilers. At the second lift are two 70,000-gallon rotary pumps and one 70,000-gallon centrifugal pump. There are three 300-horsepower water-tube boilers. Oil is used for fuel at both plants. Pumping begins about May 15. The cost of pumping plants and canal systems is given as $600,000.

There are 27 miles of main canal, 156 feet wide from center to center of the levees, which have 6-foot crown and side slopes of 2 to 1 inside and 1.5 to 1 on the outside. The slope of water surface is 1.5 inches to the mile. There are 30 miles of laterals, which have 4-foot crowns to the levees and side slopes of 1.5 to 1 inside and out. They cost $750 per mile to construct. The annual cost of maintenance is given as $20,000. The water applied to the land is not measured, and is diverted by common water gates, the rate of water rental being $6 per acre per annum. The irrigation season lasts about one hundred days. No data were given as to the amounts of water applied. The rainfall averages 7 inches during the irrigation season. During 1908 about 21,000 acres of rice were planted, and it is estimated that 29,000 acres will be planted in 1909; also that 100,000 acres can be eventually brought under canal. Before irrigating, the price of unimproved lands was $2 per acre; it is now $20, if within reach of water. Irrigated lands are worth $25 per acre. It costs $5 per acre to break the land, disk, harrow, seed, and make levees, and the average production is 10 sacks of rough rice. The crop is marketed in Beaumont, Houston, Galveston, and New Orleans. A rough estimate of the average cost of producing and marketing the crop is $27.25, and the average value $35 per acre, the average net return being stated as $7.75 per acre. The average number of acres which can be cared for by one man is given as 150, for which it is estimated he will need $1,500 for equipment.

The opportunities for settlement under this canal are limited by reason of the canal having all it can handle. Mr. C. W. Rollins, engineer for the company, estimates that 100,000 acres can be irrigated eventually in this section.

The Lone Star Company.—This company takes water from the Trinity River at its mouth. The lift is 23 feet. Three 24-inch centrifugal pumps deliver 70,000 gallons per minute and are driven by

three Corliss condensing engines, for which steam is furnished by three water-tube boilers of 256 horsepower. Including the intake, the pumping plant cost $45,000. There are 8.25 miles of main canal, 80 feet wide from center to center of the levees, and having an 8-foot berm, the center being cut out 1.5 feet deep. The side slopes are 2 to 1 on the inside and 1.5 to 1 on the outside. The canal was built on a grade of 1 inch to the mile. The cost was about $4,000 per mile. There are about 27 miles of laterals having same side slope as the main canal, but a fall of 1.5 feet to the mile. These cost $2,000 per mile. The cost of maintaining main canals and laterals is given as $500 per annum.

The water rent is one-fifth of the crop and the water is distributed to each field by gates, no measurement being made. The length of the irrigation season is given as one hundred days and the estimated amount of water applied is 30 to 35 inches. This appears to be high. The estimated average rainfall is 4 to 8 inches. During 1908, 10,150 acres of rice was under cultivation and the probable area for 1909 is 12,000 acres. The number of acres which can be served by the canal on one lift only is estimated at 50,000. Unimproved land in the vicinity was worth from $5 to $8 per acre before irrigation, but is now worth $15 without water, or $25 if water is available. The value of irrigated lands is placed at $40 per acre. The average yield is put at 11 sacks, or 44 bushels. The crop is marketed in Galveston, Houston, Beaumont, and New Orleans.

The cost of buildings, fences, etc., necessary before irrigating is estimated at $50 per acre, and the cost of producing and marketing the crop is divided as follows:

Cost to the farmer, who gets three-fifths of the crop if he rents		$12.50
Cost to the canal company, which gets one-fifth of the crop		4.00
Cost to landowner, who gets one-fifth of the crop		1.00
Total		17.50
Average value of crop, $33, divided as follows:		
To the farmer	$19.80	
To the canal company	6.60	
To the landowner	6.60	
		33.00
Average net return		15.50
Distributed as follows:		
To the farmer	7.30	
To the canal company	2.60	
To the landowner	5.60	
		15.50

The average cost of equipment required for 100 acres is put down as $900 for six mules and harness and $270 for implements, a total of $1,170, and one man can handle 115 acres of rice. To the above-named amount for equipment should be added $1,400 expense for

one year, making the sum needed to make a "one-man" start $2,570. The expenses can be reduced $250 by raising one's own seed rice. The opportunities for settlement are good for good men, wheat farmers preferred. In three years' time it is expected to bring 20,000 acres under the canal, and more is available. For this acreage 75 additional families will be needed.

Barges are used for the transportation of rice on the main canal, the capacity of each barge being 300 sacks (a carload). Each year 20,000 sacks are transported in this way. B. H. Collins, of Anahuac, states that drainage is absolutely necessary to raise rice successfully:

> We have put into force a rule that we will not water land without improved drainage. We have a ditching machine that makes a ditch 8 feet wide on top, 3 feet deep, and 20 inches on the bottom, proving very successful. There is opportunity for great improvement in seed. With C. B. Allaire, of San Antonio, N. Mex., we are this year conducting experiments along the lines of Professor Neilsen, of Sweden, with other grains. Just starting this year. Expect definite results in 1909. We get good results from pure bone meal and other fertilizers, which increase the yield from 3 to 5 sacks. The cost of fertilizer is $1 per acre, paid by landowner. We had 200 acres fertilized in 1907 and 4,500 acres in 1908.

The Cane and Rice Belt Irrigation Company.—This canal is located in Fort Bend and Harris counties and takes water from the Brazos River about 20 miles above Richmond. The water is first lifted 25 feet into Jones Creek, which parallels the river, and 17 miles below is again lifted 9 feet into a canal. The total cost of machinery, dams, canals, and right of way amounted to $250,000. There are two 45-inch centrifugal pumps at each lift. These have a normal capacity of 100,000 gallons per minute, and it is estimated they can be made to deliver safely 150,000 gallons per minute. Fuel oil is used. This entire plant is new, being used during the season of 1908 the first time.

Jones Creek acts as a reservoir, 17 miles long. The main canal is 10 miles long and has a capacity sufficient to water 25,000 acres. There are about 8 miles of laterals, having a slope of about 0.7 foot to the mile. The cost of maintenance of canals and laterals was placed at about $1,000 per year. Water is diverted to the land through 24-inch corrugated iron boxes, and the annual rental is $6 per acre. The irrigation period lasts from about May 15 to September 10.

During 1908 there were between 6,000 and 7,000 acres under rice and sugar cane, and the probable acreage in 1909 is placed at 15,000. The ultimate area which can be brought under canal is put at 60,000 acres. The value of unimproved land before irrigating was $10 per acre, but when water can be had the land is usually sold at $20 to $30 per acre. Other unimproved land is valued at $10 to $15, and the value of irrigated lands is placed at $20 to $50 per acre.

The average yield is placed at 15 barrels of rice (160 pounds per barrel) and 30 tons of sugar cane. Houston and New Orleans are the market points. The cost of preparing land for irrigation is $4 per acre, and the average value of crops is placed at $3 per barrel for rice and $2.25 per ton for cane. One man can manage 100 acres of rice or 20 acres of sugar cane up to harvest time.

The opportunities for settlement are good, and there is room under the canal for enough to take up 8,000 acres, Germans or good Americans preferred.

The Buckeye irrigation farm.—The lift from the Colorado River at Buckeye is 20 feet. The pumping plant consists of two vertical cross-compound, 400-horsepower engines, each connected to a 32-inch centrifugal pump. The combined capacity of the two is 75,000 to 80,000 gallons per minute. Fuel oil is used for steaming purposes. The plant is modern, using all possible economies. The main canal is 200 feet wide for 2 miles and 120 feet wide for 5 miles. The side slopes are 2 to 1, built with earth taken from inside of the levees. There are 8 miles of laterals and sublaterals varying from 15 to 40 feet in width. The water is distributed to farmers as needed and the irrigation period is stated to be from May 15 to August 15, on an average. The system has been idle during 1908 and no acreage is given for 1909, but it is estimated that 20,000 acres can be brought under canal. Unimproved land before irrigation was valued at $15, and the present value of unimproved lands in the vicinity is estimated to be $50 per acre. The cost of preparing a complete drainage system for the land is estimated at $2.50 per acre. Rice is the only crop grown, the average yield being 10 sacks; cost of production, $27.25; value of crop, $35; and the net return, $7.75. Buyers come to the section during the marketing season.

One hundred acres is sufficient for one man, and the cost of cultivating the same is placed at $1,000. The amount suggested as being necessary for making a successful "one-man" start is $2,000. The opportunities for settlement are good and 1,000 families is the number given for which there is room. The probable number of acres to be cultivated during 1908–9 in the vicinity is stated as 15,000, the ultimate available acreage being put at 25,000.

The Security Rice and Irrigation Company.—This plant is situated 6 miles southwest of Bay City, in Matagorda County. Water is lifted 8 to 10 feet from the Colorado River by means of a 45-inch pump of 48,000 gallons per minute rated capacity, with two 125-horsepower high-pressure boilers. Fuel oil is used for steaming purposes. The cost of the plant was not obtainable.

The main canal is estimated to be 10 miles long, 80 feet wide from center to center of the levees, which have side slopes of 1.5 to 1. Capacity is 150,000 gallons per minute and cost was $25,000. There

are 4 miles of laterals, 50 feet from center to center of the levees, which have side slopes of 1.5 to 1, with a capacity of 100,000 gallons per minute. The cost of construction is estimated to have been $8,000.

Water is turned upon rice fields until the farmers are satisfied. The method is characterized as crude and expensive, but it is the one in general use. The water rental is one-fifth of the crop and the irrigation period lasts from ninety to one hundred and ten days. The estimated amount of water applied averages 11 gallons per minute per acre during the season. There were 3,000 acres planted to rice in 1908 and probably 6,500 acres in 1909, while the area which can be ultimately brought under canal is 10,000 acres. Unimproved lands before irrigating were valued at $18 to $30, and the present value is placed at $20 to $30. It is stated that after irrigating the value does not improve greatly, as the land deteriorates for rice culture after three or four years because of the increased growths of water grasses which smother the rice. The cost of preparing land for irrigation is itemized as follows:

Plowing	$2.50
Disking and harrowing	1.50
Planting	.40
Pushing levees	.40
Total	4.80

Ten sacks constitute an average crop, and it is marketed in Bay City. The average cost of producing an acre of rice, including all cost—water rent, land rent, etc.—is $27.50, the average value of the crop $35, and the average net returns per acre $7.50. The average number of acres which can be handled by one man is estimated to be 75, and the equipment needed is 4 mules and harness, 1 heavy wagon, 1 drill, 1 disk harrow, 1 sulky plow, 1 drag harrow, 1 binder, 1 wooden push with chains, etc., and $1,500 in money.

The opportunities for settlement are said to be fair and the probable number of settlers who could be accommodated in the vicinity is estimated to be 500 to 1,000—a very high estimate—and the class of settlers wanted is given as "farmers." The probable area to be irrigated is given as 6,500 in 1909 and the ultimate acreage at 10,000 acres. Evidently these figures relate to this canal system, while the estimate of the number of settlers must apply to the whole system.

The Tres Palacios Rice and Irrigation Company.—This system is situated in Matagorda County, on the west side of the Colorado River, 4 miles below Buckeye, on the St. Louis, Brownsville and Mexico Railroad. Water is pumped from the Colorado River against an average head of 25 feet, the maximum being 32 and the minimum 7 feet. There are two 36-inch centrifugal pumps direct-connected to cross-compound condensing engines of 500 horsepower each.

There are two 300-horsepower boilers and two 250-horsepower boilers. Engines and pumps are set in a brick pit 14 feet deep. The plant cost approximately $80,000. Crude oil from Texas fields is used for fuel and cost $1.35 per barrel in tank at plant in 1907. The plant consumed 1.4 barrels of oil per acre irrigated—a cost of $1.89 per acre for fuel alone. The total cost of operating system during 1907, including superintendence, hauling, storing, and selling the crop, was $21,500, and the total receipts were $40,000.

There are 7.1 miles of main canal, 108 feet from center to center of the levees, and the longitudinal slope is 1.6 feet per mile. The carrying capacity is 200 cubic feet per second. Cost of construction, $18,000. There are 16.7 miles of laterals, 30 to 50 feet between centers of levees, which average 2 feet in height, and the cost of construction was $11,000. The fall varies from 1 to 7 feet per mile. Accurate records of cost of maintaining canals and laterals were not kept. Water is diverted to the land by means of gates, which are opened by a canal rider upon request of the farmer and allowed to remain open until the latter is satisfied. The water rental is one-fifth of the crop, but there is a movement on foot to change this to a money rental of $6 per acre. The duration of the irrigation season is given as four months—that is, the plant is run that length of time—and the amount of water applied is estimated to be 3.1 feet in depth, or 7 gallons per minute per acre. This appears to be too high, but more water is needed in the Colorado Valley than in the vicinity of Beaumont.

In 1907, 4,500 acres were planted, 8,000 in 1908, and probably 8,000 acres in 1909. Rice only is grown. Probably 50,000 acres could be covered by extending the canal, but the water is now limited to 10,000 acres. Unimproved land before irrigating was worth $2.50 to $10, and after irrigating, $15 to $20, while lands under irrigation are worth from $20 to $40 per acre. The cost of preparing land for irrigation varies from $0.50 to $4, depending upon the number of contour levees and drain ditches necessary. The crop averaged 10 barrels (of 162 pounds) in 1907, most of which was sold to local mills. The average cost of producing and marketing the crop is put at $27.25 per acre, the average total value at $35, and the average net return to the farmer at $7.75 per acre.

It is estimated that 150 acres is a fair apportionment per man. At least $3,500 is necessary for starting, if operating on a cash basis, but many farmers make crops on half this amount by getting advances.

Travis L. Smith, jr., of Eagle Lake, who was manager of this system during 1907, considers the rice industry practically developed up to its limit in this vicinity unless reservoirs are installed.

The Colorado Canal Company.—This company draws its supply of water from the Colorado River at Bay City by means of a 48-inch pump and another large pump, driven by two triple-expansion

engines. There are two boilers which use oil for fuel. The nominal horsepower of the engines is 200 and 275, respectively. There are two water heaters and two condensers, and the practical capacity of the pumps is 125,000 gallons per minute against an average lift of 10 or 10.5 feet. The cost of all installation work was $44,840.

The main canal is 14 miles long, has side slopes of 1.5 to 1, and varies from 150 to 100 feet between centers of levees. The height of the levees varies from 2 to 8 feet, depending upon the topography. There are nine locks and two trestle flumes of 260 feet each, and 19 miles of laterals, varying from 60 to 10 feet in width, on a fill varying from 1 to 4 feet. Main and laterals cost $96,400 for construction. The average cost of maintaining the main canal, laterals, and plant is estimated at $2,000 per year. Water is not measured, but the rice is kept flooded as needed. The water rental is $6 per acre per annum and the pumping season lasts from about May 1 to September 30, depending upon the dates of plantings. The crop matures in about ninety days. There were 7,800 acres planted to rice in 1908 and probably 8,000 in 1909, while the ultimate acreage under canal can be increased to about 15,000. The value of unimproved lands before irrigation is about $20 per acre and upward, while the value of irrigated lands is as high as $45 per acre. To prepare the land for irrigation costs $5 per acre and upward, depending upon the land and the character of the house, barn, etc. The average crop is 10 barrels of 162 pounds each, sometimes reaching 20 barrels. This is marketed in Bay City. The average cost of producing and marketing the crop is $20 per acre. This includes plowing, disking, seed, water, cutting, shocking, thrashing, sacks, hauling, and storage, on the basis of a 10-barrel crop. The average value of the rice is $2 to $3.75 per barrel, depending upon the grade, and sometimes $4 is realized for first-class fancy rice. The average area to be handled by one man is 100 acres, for which 4 mules, a plow, a seeder, a binder, etc., with an aggregate value of perhaps $1,000, together with about $200 for seed rice and an additional amount for feed for teams and maintenance of family until harvest. Banks and warehouses will make advances to proven men. Honest, hard-working, intelligent settlers are wanted to purchase 160-acre tracts. It is estimated that 45,000 acres were irrigated in the vicinity in 1909. No ultimate acreage has been stated.

The Northern Irrigation Company.—Water is taken from the Colorado River, near Markham, and the capacity of the pumping plant is estimated at 100,000 gallons per minute. The length of the main canal is 8 miles and that of the laterals 12 miles. No other data were obtained.

The water rental is one-fifth of the crop and the length of the irrigation season four months; the rainfall during the crop-growing

season is almost nothing; the area irrigated in 1908, 9,000 acres, and the probable area for 1909, 6,000 acres. Unimproved lands are valued at $25 before irrigation and irrigated lands at $40 per acre. Rice is the exclusive crop, and the average yield is estimated at 12 sacks per acre. This is sold in Markham, and the average value of the crop is about $40. Probably 100 good farmers could be accommodated in this vicinity.

The Eagle Lake Rice Irrigation Company.—The water supply for this system is derived from Eagle Lake, 2 miles south of the town of Eagle Lake, and also from the Colorado River. The lake covers 2,000 acres and averages 6 feet deep. When the lake supply is exhausted water is pumped into it against an average lift of 20 feet. The river plant consists of one 36-inch centrifugal pump, rope driven by one 24 by 42-inch Corliss engine, which is supplied with steam by tubular boilers. The relift plant at the lake consists of two 24-inch centrifugal pumps, driven by one 18 by 42-inch Corliss simple-condensing engine, and one 22 by 28-inch slide-valve engine. The main canal is 9 miles long, 100 feet wide, with a longitudinal slope of 2.5 feet per mile, and cost $1,250 per mile. It has sufficient capacity to serve 6,000 acres. There are 11 miles of laterals, having a slope of 3 feet per mile, and costing $400 per mile to construct. The cost of maintaining canals and laterals is estimated at $800 per annum.

Water is not measured, the water rent is one-fifth of the crop, and the duration of irrigation period is ninety days. The average depth of water applied is 3 feet and the average rainfall for the last three years is 3 inches during the irrigating season. The area under cultivation in 1908 was 4,160 acres and the probable area for 1909 is estimated at 6,000 acres; the total acreage which can be brought under canal by enlarging the canal and plant is estimated at 12,000. The value of unimproved land in the vicinity is given as $8 per acre before irrigation and $27.50 after irrigation, while the value of irrigated lands is put at $35. The cost of preparing land for irrigation is estimated at $1 per acre. Rice is grown exclusively and is marketed at Eagle Lake and Houston mills, the average cost of producing and marketing being estimated at $27.25 per acre, and the average value of crops at $35; the average yield is 12.5 barrels. About 5,000 acres are now upon the market in 80-acre and 100-acre tracts at $30 to $35, water rights included. Northern grain farmers are the class of settlers preferred. The total acreage to be irrigated in the vicinity in 1909 is estimated at 6,000, while the ultimate acreage will be 25,000.

Wells.—J. W. Leech, of El Campo, Tex., 74 miles west of Houston, on the Victoria division of the Southern Pacific system, writes that there are 125 wells in his immediate vicinity which are used for irrigating, and he estimates the acreage irrigated at 20,000, and room for more. He states that there is a large canal system which is now

being installed at Pierce, which will secure water from the Colorado River. Also that the Kinchloe Irrigation Company at Glenn Flora has a large plant in operation. These are the only systems in that vicinity except small canals from wells. He says that pumps of all makes, mostly operated by gasoline, are used in bringing the water to the surface from the wells, in which the water rises nearly to the ground level.

The following is a list of canal companies in Group I, as far as ascertained. The acreage for 1907 and 1908 is from the "Rice acreage report in Texas," issued by the Texas Rice Farmers' Association, of which A. E. Groves, of Houston, is secretary and treasurer. The last column is from the Southern Pacific Railroad Company's "Rice belt" map, and gives the approximate ultimate acreage which can be served as compiled by Mr. Duller, of Houston.

List of canal companies and acreages.

Name.	Canal number.	Area. 1907.	Area. 1908.	Approximate ultimate area.
		Acres.	*Acres.*	*Acres.*
Oriental Seed Rice Co	57			3,000
Cow Bayou Canal Co	2	3,000	3,000	15,000
Port Vernox Oil Co	1			7,000
Kechi Rice Co	58			5,000
Des Moines Rice Co.[a]			1,200	
Samuel Wilson Canal Co	41			5,000
Giles Bros. Co	42			5,000
Clark Canal Co.	40	1,500	1,500	5,000
Adams Bayou Canal Co	39	3,284	3,284	15,000
Orange Company Irrigation Co	62	3,340	3,340	4,000
Port Arthur Irrigation Co	27	7,950	9,000	15,000
McFadden-Weiss-Kyle Canal	4	9,000	15,000	20,000
Neches Canal Co	6	23,000	21,000	
Beaumont Irrigation Co	5	17,000	16,000	20,000
Ed Moore	73			1,000
Jefferson County Canal Co	3			20,000
Lowell Bros. Canal	72			1,000
J. C. Ward	77			1,000
J. H. Garland Canal				1,000
J. H. Hoopes	76			1,000
George Gill	74			1,000
Schumacher & Fox	75			1,000
Vitrobe Brothers	68			1,000
Mr. Davis	70			1,000
C. A. Place Canal	67			1,000
Taylors Bayou farm	43	3,000	3,000	5,000
Hillibrandt Bayou Canal	44			5,000
Cameron & McClure	69			1,000
Lone Star Canal	9	10,136	10,237	20,000
Farmers Canal	8	5,400	5,400	25,000
Old River Canal	47	9,646	10,000	10,000
Raywood Canal	7	11,000		30,000
Kentucky Rice Irrigation Co.	45			5,000
Trinity River Rice and Irrigation Co.				
Houston Irrigation Co	37			5,000
San Jacinto Model Rice Farm	46	10,000	8,500	10,000
Crosby Canal Co	10			10,000
Harris Company Land and Irrigation Co.	36			5,000
Sheldon Canal Co.[a]				
Miller Bros. & Mercom Co	87	2,505	2,505	30,000
Deepwater Canal Co	35			5,000
B. W. Camp	34	2,230	2,250	5,000
W. C. Stockton	79			2,000
S. J. Freeland	78			2,000
Exline Canal	80			800
Fort and Fort	81			600
Oberhelman	53			2,000
Krud Canal				600

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 71. T. U. Taylor. 1902.

List of canal companies and acreages—Continued.

Name.	Canal number.	Area. 1907.	Area. 1908.	Approximate ultimate area.
		Acres.	*Acres.*	*Acres.*
Hurd Canal	33			5,000
Herrick & White	85			5,000
J. C. Walker	84			2,000
Jackson Lake Canal	54			3,000
Rodemiller Canal	32			5,000
Angleton		4,260	2,500	
Munson Canal Co				
Brazoria Irrigation Co	11			30,000
Sugarland Canal	31			5,000
Cane and Rice Belt Irrigation Co	12			75,000
Wallis Canal	13			10,000
Stewart Canal	86	1,528	2,400	3,000
Buckeye Canal Co	49	4,245		5,000
Kloor Canal	66			2,000
Security Canal	23	3,520	3,000	10,000
Tres Palacious Canal	25	4,889	4,889	10,000
Gravity Canal	22	5,660	4,500	25,000
Colorado Canal	21	5,500	5,000	15,000
Northern Canal	24	9,595	9,000	10,000
Matagorda Canal	20	6,090	5,500	10,000
Moore-Curtis Canal	48	7,896	5,250	15,000
Bay City Canal	19	400		15,000
Prairie Bluff Canal	85			2,000
Southern Irrigation Co	18	13,000	8,500	20,000
A. P. Borden Irrigation Co	65			30,000
Glen Flora Canal	68			5,000
Kenchloe Canal		13,500	8,500	
Lakeside or Donovant Canal	17			5,000
Garwood Canal	15	1,720	1,720	5,000
Eagle Lake Rice Co	14	3,500	4,000	10,000
Tuttle & Harmon	30	3,535	3,000	10,000
Jackson County Irrigation Co	63			2,000
Gale Plant and Irrigation Co	24			10,000
Red Bluff Canal	29			10,000
Southern Irrigation Co	55			10,000
Saki Farm or Nipon Irrigation Co	26			20,000
Buchel Plant	50	100		10,000
Victoria Rice and Irrigation Co. [a]		5,500	2,500	
Rooth Canal		300	300	
Osceola Canal		500		
Cove Canal		1,200	1,200	
Onishi Canal		1,200	1,000	
Frost Canal		3,500	8,000	
Dheldon		5,000	4,500	
Katy district		2,000	2,200	
Ganado district		5,500	6,000	
Chesterville district		4,680	4,680	
Garwood district		1,720	1,720	
Mykawa district		2,470	1,260	
Palacios district		1,720	1,000	
El Campo district		7,900	8,960	
Friendswood district		1,720	1,900	
Des Moines Canal			1,700	
Waterhouse Rice Canal			1,000	
Scattering			3,500	
Total		257,239	229,925	727,000

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 158, pt. 5.

GROUP II.

The region along the lower coast country from Beeville to Brownsville is included in Group II. Around Beeville and Corpus Christi truck and fruit have been grown for many years, and rice has been tried also in the lower portion of the Coastal Plain, but appears to have proven less profitable than other crops. Only one brief description of an irrigation system at Beeville was secured, the information being furnished by the superintendent of the state

experiment station. For the large systems near Brownsville a few reports have been received direct from some officers of the companies, but the bulk of it was supplied by W. L. Rockwell, of this Office.

The State Experiment Station.—Water is derived from a 6-inch bored well, 174 feet deep. The lift is 60 feet, the water being pumped at the rate of about 60 gallons per minute by means of a 6-horsepower gasoline engine, into a 100,000-gallon earthen reservoir, which is lined with a coat of mastic consisting of 25 parts coal tar, 2 parts lime, and 73 parts sand. Mr. Waschka, the superintendent of the station, estimates that it would cost about $1,400 to build complete a plant of this kind. If the water is properly distributed, 8 to 10 acres can be irrigated. Mr. Waschka writes:

> It is probably better to say that there is no irrigating done in Bee County, except a few small truck patches that are irrigated from wells, water being drawn by gasoline engines and windmills. There are no live streams through this county, but good water is inexhaustible at a depth of about 150 feet.

The surface of the country at the experiment farm, as well as to the north and west of Beeville, is undulating and in the natural state is covered with mesquite and live oak. The soil of the ridges is a red and black sandy loam underlain at a depth of 1 to 4 feet with a rotten limestone rock, into and through which the roots of the trees penetrate. On the lower ground below this cap rock the subsoil is a yellowish, pervious clay 2 to 4 feet below the surface. The soil to the southeast of Beeville consists of a light sandy loam, with a clay subsoil, and the landscape is somewhat more uniform than in the opposite direction. At the experiment station about 4 acres are planted in citrus fruits. Three-year-old Duncan, Royal, and Pernambuco pomelos stand 6 to 7 feet high, and bore in 1908, 400 to 650 fine fruits. Three Villa Franca lemon trees, 8 feet high, bore 1,000 fine merchantable lemons. The Japanese varieties of oranges are making an exceptionally fine showing. With proper care there seems to be little doubt that the hardier varieties of citrus fruits will be a commercial success in this section. By withholding moisture, excepting in proper growing periods, from this naturally well-drained soil, the trees may be rendered sufficiently hardy to withstand the frosts of this region. It is necessary to supply moisture occasionally during the fruiting season, and this can be supplied by wells, from which good water can be obtained at a depth of 100 to 125 feet. As this district lies between the humid and semiarid sections of the State, it receives a more even rainfall during the growing season than portions farther south. The station has experimented also with olives in a number of varieties, all of which are doing well.

Though it is necessary to occasionally supply moisture to fruit trees in order to produce a first-class quality of fruit, it is very seldom that there is not plenty of rainfall to grow fine vegetables. Cabbage,

cauliflower, turnips, beets, radishes, spinach, and lettuce can be grown there during the fall and winter to supply the northern markets.

The Brulay estate.—This farm is situated 8 miles below Brownsville, on the left bank of the Rio Grande, and is equipped with a 10-inch centrifugal pump having 12-inch spiral-riveted suction pipe 500 feet long. This long suction was made necessary because of a change in the channel of the river which left the pumping plant that far away from the bank of the river. The lift varies from 4 to 19 feet, according to the stage of the river. The total area under irrigation is 200 acres, of which 160 acres is in sugar cane and 40 acres in mixed crops. The canal is probably 2 miles long and 2 feet wide on the bottom. The yield of sugar cane is 30 tons to the acre.

The Indiana Cooperative Canal Company.—This system is under construction and will use as a reservoir the Resaca de la Palma, which is 200 feet wide and 15 feet deep and may be filled any time the river rises 7 feet above the normal stage. The pumping plant is on the Rio Grande, about 3.5 miles below Brownsville. The cost of construction of headworks was about $30,000, the cost of pump and engine $6,500, and the cost of setting same $6,000. The capacity of pump is given as 30,000 gallons per minute, and the maximum lift as 10 feet The pump is direct-connected to a 14 by 20 inch automatic engine, which receives steam from a 150-horsepower boiler. The length of the main canal is 25 miles. At the river it is 24 feet wide at the bottom, 11 feet deep, and has side slopes of 2 to 1. Its carrying capacity is 250 cubic feet per second and the cost was $120,000. There are 30 miles of laterals costing $1,000 per mile for construction. The side slopes are 1½ to 1 and the longitudinal slope 18 inches per mile. The cost of maintenance for canals and laterals is not known, but is estimated at $1 per acre. Water will be measured by weirs, using the Reclamation Service tables, and the annual rental will be based on a fixed charge of $1 per acre for the general expenses, and the additional expense for fuel, oil, engineer, etc., will be prorated according to the amount of water used. No profits are figured on, and any unused remainder of the fixed charge will become a sinking fund for the renewal of machinery, etc. The irrigation period will be continuous throughout the year and the amount which will be needed for each acre is estimated at 2 acre-feet per annum. The average rainfall is slightly more than 27 inches, according to the U. S. Weather Bureau records. No acreage was planted during 1908, but 2,000 acres are expected to be under cultivation in 1909. The total acreage which can be served is placed at 25,000, and eventually 37,000 acres in the section east of Brownsville on all canals.

The Piper Texas Plantation Company.—Water is pumped from the Rio Grande, 3 miles below Brownsville, by means of a 6-inch centrifugal rope-driven pump, working against a lift which varies from 10 to

20 feet, according to the stage of the river. There are 6 miles of main canal, 4 feet wide at the bottom, 2 feet deep, and side slopes of 2 to 1, and about 12 miles of laterals 1.5 feet deep. For 1908 the acreage was given as 135 acres in sugar cane, 150 acres in cabbage, 30 acres in melons, 200 acres in corn, and 25 acres in potatoes. The estimated total area for 1909 is 800 acres.

The Kirby Plantation.—This farm is located about a mile below Brownsville and draws water from the Rio Grande by means of a 10-inch centrifugal pump with a lift varying from 6 to 18 feet, according to the stage of the river, the capacity of the pump being 5,000 gallons per minute. The cost of pump and engine installed was about $800.

For 1908 there were 134 acres and for 1909 there will be probably about 260 acres under cultivation. The crops grown are corn, melons, cabbage, potatoes, beans, and sorghum.

The Brownsville Irrigation Company.—Water is pumped into the canal from the Rio Grande at Brownsville against an average head of 7.5 feet by a 36-inch and two 24-inch centrifugal pumps, rope-driven by two 100-horsepower slide-valve engines and one 225-horsepower Corliss engine, steam being furnished by two 125-horsepower tubular boilers and one 260-horsepower water-tube boiler. The combined capacity of the pumps is stated as 100,000 gallons per minute. The fuel used is mesquite wood. The total first cost of plant is estimated at $40,000 and the estimated annual cost of maintenance at $10,000.

There are 35 miles of main canal and larger main laterals varying in width from 120 to 30 feet and having a fall of 1.5 feet per mile. The first cost was about $85,000. The annual cost of maintaining canals and laterals is stated as about $11,000. The water furnished is not measured, but is furnished on a flat rate of $4 per acre per annum for corn and cotton, $6 for sorghum, sugar cane, and alfalfa, and $10 for truck. The irrigation season lasts practically all the year and the amount of water required depends upon the crop. For corn and cotton it is estimated as being equivalent to a depth of 12 inches, while for sugar cane it is given as 28 inches. According to the report of the U. S. Weather Bureau, covering a period of 35 years, the average rainfall during the cotton-growing season was slightly in excess of 7 inches.

For 1908 there were 4,500 acres under canal and for 1909 the acreage will be probably 5,000, while the ultimate area that can be brought under the canal will be about 30,000 acres. Before irrigation, lands in the county were worth about $1 per acre, unimproved. They are worth now $40 to $100 and irrigated lands from $60 to $150 per acre.

Average cost and value per acre of crops, and number of acres one man can tend.

Crop.	Average cost of producing and marketing.	Average value per acre.	Area one man can tend.[a]
			Acres.
Corn	$16.50	$27.50	50
Cotton	22.00	45.00	50
Sorghum	20.00	40.00	70
Alfalfa	23.50	75.00	60
Sugar cane	79.50	160.00	40
Onions[b]	140.00	350.00	....
Cabbage	40.00	200.00	10
Celery	800.00	1,500.00	5
Truck	100.00-150.00	300.00-400.00	5

[a] Extra help often required at harvest time.
[b] If fertilization is needed add $20 to $50 to cost of production.

The average funds and equipment needed are listed as 1 team, $300; wagon, $75; cultivator, $40; harrow, $15; disk plow, $75; mower, $50; rake, $25; garden tools, $150; and $500 in money. There is plenty of room for more settlers, the estimated number being given as 2,500 farmers. The probable acreage irrigated in the vicinity for 1909 is 5,000 and the ultimate acreage 30,000.

The San Benito Land and Water Company.—This plant takes water directly from the Rio Grande and has reinforced concrete head works from the flow line to the bottom of the river which, with eight gates, cost $45,000. The cost of maintenance of head works is said to have been $2,000 in 1908. There is one 78-inch propeller pump and one 24-inch centrifugal; the combined capacity of the pumps is 100,000 gallons per minute against a 10-foot lift. Power is furnished by a slide-valve engine and tubular boilers. The cost of the pumping plant was $12,000 and the cost of maintenance in 1908 until about July 15 was $1,900. The total cost of construction, including the lateral system, is given as $250,000. There are 27.5 miles of main canal, mostly a natural waterway, and the slope is 1 foot to 8,000 feet. The carrying capacity is placed at 575 cubic feet per second and the cost of canal construction at $95,000. There are 34 miles of laterals having a fall of 2.5 feet in 5,000 feet, and their cost was about $90,000. The cost of maintaining canals and laterals from January 1 to July 15, 1908, was about $2,000. Water is sold at a flat rate of $4 per acre for cotton and $6 for sugar cane and alfalfa. Irrigation continues all the year round, and the average amount of moisture necessary to apply is 20 inches, the rainfall being given as 24 inches—the Weather Bureau records show the average to be 27 inches at Brownsville.

During 1908 there were only 2,000 acres under cultivation, the system being in process of construction, but it is expected that 10,000 acres will be planted in 1909, while the ultimate area which can be brought under canal is estimated at 50,000 acres, of which this company owns 36,000. The value of unimproved lands before the

irrigation system was installed was $3 per acre; after irrigation it was increased to about $50 per acre, while the irrigated lands are valued at $75 to $250. The principal crops and their average yields are given in the following table:

Average yield, cost, value, and net returns of crops, and number of acres one man can tend.

Crops.	Yield per acre.	Average cost per acre.	Average value per acre.	Average net returns per acre.	Acreage one man can tend.[a]
					Acres.
Cotton	1 bale	$22.00	$45.00	$23.00	50
Corn	50 bushels	16.50	37.50	21.00	50
Alfalfa	6 tons	23.50	75.00	51.50	60
Sugar cane	40 tons	80.00	160.00	80.00	40
Onions	22,000 pounds	120.00	350.00	210.00	5

[a] Extra help needed in harvesting.

The equipment and funds needed for one man should consist of one team of mules and harness ($300), wagon, plow, mower, rake, harrow, garden tools, and about $500 in money. Many men succeed without anything to begin with if they can secure advances from merchants or landowners. The opportunities for settlement are good and the probable number who can be accommodated is placed at 13,000. Honest, hard-working Americans, Swedes, Germans, or Bohemians are welcome.

The Harlingen Land and Water Company.—Water is pumped from the Rio Grande at Harlingen, 19 miles above Brownsville, by means of a 24-inch and two 36-inch centrifugal pumps run by one 125-horsepower and two 275-horsepower engines. This plant is in process of construction and the cost data are not available. The main canal is 22 miles long, 30 feet wide on the bottom, and side slopes 2 to 1. The average depth is 5 feet and the grade 1.5 feet per mile. There are approximately 50 miles of laterals having 6-foot bottoms, 2 to 1 side slopes, and a depth of 3 feet. The soil is rich, sandy silt, containing a large percentage of vegetable matter. The available acreage is about 40,000, and the land subject to irrigation is valued at $50 to $65. The water rental will be $10 per acre for truck, $6 for sugar cane, alfalfa, and sorghum, and $4 for cotton and corn. These water rates are based on one crop per season, but if a second crop of other products is raised the additional charge is one-half the original charge. The same crops as under the San Benito system may be grown with equal net returns. There were about 200 acres in sugar cane, sorghum, corn, and cotton in 1908, and there will probably be 2,000 in 1909. It is the intention of the owners to increase the acreage in sugar cane and erect a sugar mill.

La Gloria Canal Company.—The system now under construction by this company will pump water from the Rio Grande at Santa Maria by means of an 18-inch centrifugal pump. There are 5.5 miles

of main canal, 20 feet wide at the bottom and 2 to 1 side slopes, and a water depth of 3 feet. For the first mile the grade is 3.5 feet and beyond that 2 feet per mile. Four and one-half miles of laterals are built and there will probably be 20 miles of these. The side slopes are 2 to 1 and the depth about 2 feet. The company owns 1,700 acres, but there are about 2,700 acres additional west of the canal, which can be served by it.

The Santa Maria Irrigation Company.—This is the oldest irrigation system on the river, with the exception of the Brownsville Irrigation Company and the Brulay estate. Water is pumped from the river by means of an 18-inch centrifugal pump run by a 75-horsepower engine and 100-horsepower boiler. An additional 24-inch centrifugal pump was installed during the fall of 1908. The main canal is 4.5 miles long and the width of the canal proper is 10 feet on the bottom, with approximately 4 to 1 side slopes and 3.5 feet deep. Of this, 2 miles have a longitudinal slope of 0.55 foot per mile, the remainder having a fall of 2 feet per mile. There are 7.5 miles of laterals. There were under cultivation in 1908, 4,000 acres in beans, onions, cabbage, and other truck, including 5 acres of celery, which brought a net return of $700 per acre. The land under this section is particularly well adapted to truck growing.

The American Rio Grande Land and Irrigation Company.—This will be the largest system on the river when it is completed. Water is pumped from the Rio Grande into an old channel which has been utilized as a reservoir and which has an area of 560 acres and a capacity of 3,000 acre-feet. An emergency canal 2 miles long leads around this reservoir into the main canals. Two 36-inch centrifugal pumps, operated by a 250-horsepower 3-phase motor, and having a capacity of 28,000 to 34,000 gallons per minute, depending upon the stage of the river, have been installed and operate against a head varying from 4 to 24 feet. Floor space is available for a 48-inch centrifugal pump which will be installed later. The power house is located at Mercedes, 6 miles from the pumping station. It is equipped with steam turbines and electric generators and cost $70,000. The fuel used is crude oil. There are 18.5 miles of main canal and 50 miles of laterals, the cost of both being $490,000. The cost of maintenance is not yet determined. The emergency canal has a cross section of 400 square feet at low-water level in canal and is 2 miles long. The north trunk canal is over 100 feet wide, but no data regarding the east trunk are available. Water will be charged for at the rate of $1 per acre per irrigation, but nothing is said as to the quantity which may be used at one time. The irrigation period lasts the year round. There were 1,000 acres in cultivation in 1908 and there will be probably 5,000 in 1909, and ultimately 100,000 acres will be served. Before this plant was constructed the lands were valued at $7 per

acre; unimproved lands sell now for $50 to $100 per acre, and irrigated lands for $75 to $150. The crops which may be cultivated are stated to be "everything that grows." It is estimated that 3,000 families can be accommodated on this canal alone.

The total outlay on this plant, including power and pumping machinery and canal system, will be $1,000,000.

Withers Canal.—This canal is being installed 3 miles above Mercedes, at Llano Grande. There is one 24-inch centrifugal pump, which lifts water from the Rio Grande, and the cost of the pumping plant was $11,000. The main canal is 20 feet wide on the bottom, side slopes 2 to 1, and a depth of 5 feet. The water slope is 1.5 feet per mile, and there are 4.5 miles completed, which will be extended to perhaps 15 miles. There are now 200 acres in truck, 3 acres in Satsuma oranges, and 2 acres in olives. Ultimately, upward of 10,000 acres can be served by this system.

The La Blanca Agricultural Company.—This company is located at Donna, Tex. Its president was unable to furnish the desired data, but states that he came to that region in 1902, when lands were worth $1.25 per acre. His company was organized and began experimenting upon the products which could be grown under irrigation, notwithstanding there were then no railroads to furnish facilities for marketing. A small pumping plant was installed and about 400 acres were irrigated, but no cost data were kept. Now lands under the company's canals are worth from $50 to $80 per acre, but land which can not be brought under irrigation is scarcely salable at any price. The crops during the past winter and spring averaged 500 bushels of onions per acre, 200 to 500 bushels of cucumbers, a heavy crop of alfalfa, and 40 to 60 bushels of corn. Two crops of corn can be grown in a year. Sugar cane is estimated to yield 40 to 60 tons per acre. Not less than 160 carloads of truck were shipped from Donna station during the spring of 1908. A very large irrigating plant is being installed on the lands of the company, which will reach out 18 miles from the river and will serve 25,000 acres.

La Donna Canal Company.—The maximum lift from the Rio Grande is 14 feet, at Donna, Hidalgo County, where this system is being installed. There are two 30-inch pumps, direct-connected to two 150-horsepower compound condensing engines. Two 150-horsepower water-tube boilers furnish steam. When completed there will be 18 miles of canals. The number of acres in cultivation in 1908 was 1,000; the probable number for 1909 will be 3,000, and the ultimate number to be reached by canal will be 17,000. The present value of unimproved lands is put at $50 per acre and of irrigated lands $100 to $150 per acre. The average cost of preparing the land for irrigation is $25 per acre. The crops to be grown will be sugar cane, alfalfa, corn, and all kinds of truck, onions being a specialty. For 1908 the aver-

age yields are given as follows: Onions, 450 bushels; cucumbers, 200 bushels; corn, 40 to 50 bushels. The products are marketed in Denver, Minneapolis, the East, and the South. Probably 300 settlers can be accommodated on the canal system.

Closner canals.—On the Closner ranch, near Hidalgo, there is an 18-inch centrifugal pump installed, with which water is lifted from the Rio Grande to irrigate 150 acres of alfalfa and 600 acres of sugar cane. Mr. Closner has taken considerable care in the preparation of his land for alfalfa and has produced hay of excellent quality. His fields yield upward of 6 tons per season and his hay sells at an average of $12 per ton. The sugar cane yields 40 tons, or 3 tons of sugar per acre, worth $180 to $200. Sold in large tracts in the wild state lands bring $20 per acre. Under a canal system the prices range from $40 to $60 per acre; under irrigated cultivation the value varies from $75 to $150 per acre.

The Hidalgo Canal Company.—There are two lifts on this canal, the second being 6 miles back from the river. The first lift, at McAllen, has two 24-inch centrifugal pumps, which raise the water 6 to 18 feet, according to the stage of the river, and at the second lift there is a 15-inch and another 24-inch centrifugal pump, which raise the water an additional 26 feet. The capacity of the pumps at the first lift is 36,000 gallons per minute, and at the second lift 27,000 gallons per minute. Eight thousand acres are irrigated from the first lift, and eventually 18,000 acres will be irrigated by the canal system. The crops now grown are alfalfa, Egyptian corn, sorghum, and truck, but grapes, peaches, apricots, and other fruits will be cultivated on the second bench land.

The Rio Bravo Irrigation Company.—The intake of this canal system is located 600 feet above the intake of the Hidalgo Canal, where there is a 24-inch centrifugal pump of 20,000 gallons capacity per minute. The lift varies from nothing to 20 feet, according to the stage of the river. The cost of the pumping plant was $4,000. The main canal is 30 feet wide at the bottom, has side slopes of 2 to 1, and falls 1 foot in 4,000 feet. The company owns 4,000 acres, but lands adjacent, to the extent of 12,000 acres, can be served by the canal when completed. The entire cost of the system will be $40,000. Land will be sold to farmers direct at $50 per acre, including one $10 share of stock in the company for each acre purchased for a permanent water right, the purchaser to pay for water for entire acreage bought at the rate of $2 per annum from the time water is ready to be delivered to the land.

La Lometa Canal Company.—This system is situated at Mission, Hidalgo County, and is in process of construction. Water will be lifted 18 to 28 feet from the Rio Grande by means of centrifugal pumps, of which there are two now in operation, having a combined

capacity of 40,000 gallons per minute. The cost of construction was $18,000. Four miles of main canal is completed, which will be extended. It is built so that increased capacity can be added as required. There are 7 miles of laterals completed and more under construction. The general slope is 1 foot per mile. There has already been expended $100,000. The system of measuring water to farmers has not yet been installed, but the system of "miner's inches" will be used. The rate of water rental is put at $1 per watering, and it is expected that 24 to 30 inches depth will be needed during a season. Five hundred acres were under cultivation during 1908 and it is expected to cultivate 2,000 to 5,000 acres during 1909. The area which can be brought under canal ultimately is stated at 20,000 acres. Unimproved lands in the vicinity before irrigating are valued at $20 per acre. The present selling price of lands under irrigation is $50 to $150 per acre. The cost of preparing land for irrigation is $25 per acre and the crops raised are winter vegetables, alfalfa, sorghum, cane for fodder, cotton, sugar cane, citrus fruits, figs, and dates, and a few bananas. The average value of crops is placed at $25 to $300 per acre, but the average net return has not yet been determined. Land can be bought for one-fourth cash payment, balance in one, two, and three years, with interest at 6 per cent. One man can care for 5 to 75 acres, depending upon the character of the crop, and it is estimated that there are 500,000 acres capable of cultivation on the Texas side of the Rio Grande delta. Settlers should have at least $2,000 cash when making a start.

W. S. Dougherty Canal.—Three miles above Mission there is a small irrigation system belonging to the estate of W. S. Dougherty. A 12-inch centrifugal pump raises water from the Rio Grande against a maximum lift of 20 feet, and has a capacity of 8,000 gallons per minute. The main canal, 1 mile long, has a width of 6 feet at the bottom, a depth of 4 feet, and side slopes of 2 to 1. There are 10,000 acres in this ranch, but only 140 acres were irrigated in 1909, of which 108 acres were in Bermuda onions and 32 acres in alfalfa and corn.

As far as could be learned, the above descriptions cover all the irrigation systems now in operation or under construction on the lower Rio Grande, but within the area classed as Group II are other canal systems concerning which no data were available. However, the following data were obtained regarding a single small plant irrigated from a well.

Thompson Garden.—A. C. Thompson and W. C. Thompson have 12 acres in general garden truck 1.5 miles west of Falfurrias, which they irrigate from an artesian well. The flow of the well has been increased by placing a centrifugal pump 17 feet below the surface, the pump being run by an 8-horsepower gasoline engine. One hundred and eight gallons per minute are delivered and this is supposed to be the

capacity of the well. It is expected to install a windmill soon which will pump water from the well into a small reservoir which is now in place at the well, and into another which will be constructed 800 feet distant. The well is 605 feet deep, lined with 5-inch casing, three-sixteenth-inch thick, down to the clay stratum which overlies the one in which water is found. In this latter stratum the casing is 4.25 inches in diameter and 20 feet of it is pierced by 1,600 half-inch holes. The growing season continues the year round, but not much water is necessary in the winter. The gardens are just being put into shape and only 12 acres are now under cultivation, which will be increased to 15 acres in 1909. Unimproved lands are valued at $100 per acre and it costs $30 per acre to bring them under irrigation. There is plenty of good land for sale at $20 to $100 per acre from 1 to 5 miles from the railroad, and there is room for 500 settlers, who should be energetic and persistent, having $2,000 to $5,000 to invest. Mr. Thompson, who furnished the above information, estimates that 10 per cent of the land in that section is irrigable. Below is given a list of well systems compiled from existing data, but as this is 4 to 6 years old the list does not begin to represent conditions as they exist now. The table embraces those systems in Group II for which data were obtainable.[a]

Irrigation systems in Group II.

Name of company.	Locality	Source of water.	How introduced into canal.	Cost exclusive of land.	Area cultivated.	Crops raised.
					Acres.	
Rankin farm	Beeville	3 wells	Pump		20	Truck.
Messenger farm	do	1 well	do	$750.00	10	Do.
Stovall farm	do	do	do	425.00	(a)	Corn, beets, truck.
Eidson farm	do	do	do	800.00	1	
Muckelroy farm	do	do	do	476.45		
Grissett place	do	2 wells	do		2	Truck.
McDowell farm	do	do	do		4	Do.
Koon place	do	1 well	do		5	Do.
Bowen farm	do	do	do			Do.
Mock farm	do	do	do			Do.
Elliott farm	do	2 wells	do		5	Do.
Huff farm	Corpus Christi		do		35	Do.
Kleberg farm	do		do		15	Do.
Trott farm	do	Well	Pipe line		8	Do.
Everhardt farm	do	Rain and well	Pump		7	Do.
Heath farm	do	Well	Windmill		(a)	Do.
Knox farm	do	do	do		4	Do.
Kenedy ranch		8 wells				
Armstrong ranch		19 wells				
El Sauz ranch		4 wells				

a Small tract.

GROUP III.

Group III includes the territory lying in the vicinity of San Marcos, New Braunfels, San Antonio, Seguin, Eagle Pass, and Del Rio, together with the intervening territory, and while there are many comparatively small irrigation systems in this group, water

a U. S. Dept. Agr., Office Expt. Stas. Bul. 158, pt. 6.

for which is derived from both streams and wells, little first-hand information could be secured. However, it is probable that the tabular data given after the few detailed descriptions which were obtainable more nearly represents conditions as they now exist than would be the case for either Groups I or II, because there has been less recent development in this area, except for the portion lying along the Rio Grande at Laredo, Eagle Pass, and possibly Del Rio. Irrigation on the systems of this group is devoted chiefly to the raising of garden truck and staple products

Collins garden.—Three miles west of San Antonio F. F. Collins irrigates 172 acres from a 12-inch artesian well, 700 feet deep, the natural flow of the well being relied upon entirely for the supply, which Mr. Collins states would furnish water enough for 400 acres if the flow were conserved in a reservoir of sufficient size. The land has a fall of 10 feet to the mile east and 8 feet to the mile south. The laterals run north and south from the main canal every 300 feet. Each lateral is 1,150 feet long (the width of the tract, which is about a mile long) and about twelve rows, running east and west, are watered at a time. The well cost $4,500, but the canal and laterals were constructed very cheaply and the cost could not be approximated. The flow of the well is applied to each acre about one day in every seven, and the rental is $15 per acre for water, house, and barn, and $5 per acre for the land. The estimated amount applied per acre per annum is 2 acre-feet. The tract owned by Mr. Collins cost $50 per acre in 1900 and the price was then considered high. Recently $200 per acre has been paid for land near by. The land is divided into 12-acre tracts and the cost of a house and barn and hydrant water for each tract was about $1,000. Mr. Collins has refused $500 per acre for his farm.

Data on the cost of producing and marketing various vegetables were not obtainable, but it is stated that some renters clear as much as $200 per acre while others make little or nothing. One man with help can care for 12 acres and each beginner should have $1,000. The entire tract of 172 acres was irrigated in 1908 and the same will be done in 1909. In the vicinity it is estimated that 2,000 acres will be under irrigation in 1909 and 20,000 acres or more are available for irrigation in that section. For market gardening Belgians are preferred and Germans next. Mr. Collins, who furnished the information, states that the artesian belt is limited, but that by conserving the flow in reservoirs a large scope of country can be irrigated. He states that the slope of the land is so uniform that there is no difficulty in preparing it for irrigation.

The Schriever and Half System.—This irrigation system is situated 4 miles west of Pearsall. The source of the water used is a 6-inch artesian well, 1,450 feet deep, which discharges 400 gallons per

minute into an earthen reservoir 200 feet square, built up 8 feet above ground. The reservoir is situated in the center of the irrigated area, and from it the water is distributed over the ground in small plowed ditches. The total cost of boring the well, including casing, was $6,000, and the cost of building the reservoir was $500. The cost of maintaining reservoir and ditches is practically nothing. The rental for both land and water is one-third the gross production, and the area cultivated in 1908 was 200 acres. For 1909 the same area will probably be irrigated. Unimproved lands before irrigating were valued at $8 to $10 per acre, and the cost of clearing and breaking at $2 to $5 per acre, but this does not include any part of the cost of the irrigation plant. Irrigated lands are valued at $50 per acre. The crops and yields are as follows: Onions, 20,000 pounds per acre; cabbage, 1,600 pounds; sweet potatoes, 300 bushels; watermelons, 1 carload. These are marketed in Pearsall.

The Comanche Ditch Company.—This is a chartered stock company with a capital stock of $25,000, with an office at Batesville, Zavalla County. A timber and mud dam across the Leona River constructed thirty years ago serves to divert the water on the right bank at a point about 2.5 miles above Batesville. The landowners constitute the stockholders, each acre being considered one share. Assessments are levied from time to time to maintain ditches and rebuild the dam when demolished by floods. The main canal is about 2.5 miles long, 4 feet wide, and in places is 6 or 7 feet deep. The irrigation period continues seven months, and no attempt is made to measure the water applied to the land, the only rental being the variable assessment levied in order to keep ditches and dam in repair. In 1908, 500 acres were irrigated, and the same acreage will be irrigated in 1909, though it is estimated that nearly 1,500 acres can be brought under canal. Unimproved lands before irrigating were valued at $1 per acre, and the present value of unimproved land in the vicinity is $4 per acre. It costs $8 per acre to bring the land under irrigation, after which it is valued at $35. The crops grown are Johnson-grass hay, corn, cotton, onions, garden truck, and peaches. The products are marketed in Uvalde. The cost of production and marketing depends upon the crop grown. To produce a crop of onions costs $150 to $175 per acre, with a gross return of $300 to $350. To produce a year's growth of Johnson-grass hay will cost $12 to $15, and the gross returns will be $30 to $35. The opportunities for settlement are good, there being room for 75 families in the vicinity. Quite an acreage in the Leona Valley can be irrigated by pumping from the stream and from wells.

Las Islitas Irrigation Company.—This company is located near Islitas, about 15 miles above Laredo. Water is pumped from the Rio Grande against a 57-foot lift by a 10-inch centrifugal pump hav-

ing a capacity of 4,000 gallons per minute. The cost of pumping station was $6,000, and the maintenance and operating expenses are $10 per day. There are 2.5 miles of canal, costing $500 per mile, the slope of which is 1 in 600. There are 10 miles of laterals, having the same slope as the canal and costing $50 per mile. The cost of maintenance of canals and laterals for 1907 was $400. The water applied to crops is not measured, but is charged for at the rate of $1 per acre for each time a crop is irrigated. The irrigation period extends from June to April, and the average depth of water applied is estimated at 5 feet—very much in excess of what is necessary. There were 300 acres in cultivation in 1908, and 400 acres will probably be put in cultivation in 1909. By sufficiently increasing the pumping capacity of this system 1,200 acres can be reached.

Unimproved lands before irrigation began were worth $10 per acre, afterwards $30. It costs $15 an acre to prepare the land for irrigating, and the value of irrigated lands is placed at $150 per acre. The crops grown are alfalfa, onions, and cabbage. These are marketed all over the United States and in Canada.

Average cost, value, and net returns of crops and area one man can tend.

Crop.	Average cost per acre of producing and marketing.	Average value per acre.	Average net returns per acre.	Area one man can tend.
				Acres.
Cabbage	$25	$75	$50	20
Onions	150	300	150	10-15
Alfalfa	[a] 4	40	24	60

[a] Per cutting.

If land is leased, $2,000 will be needed to make a start and run one year for 25 acres. The opportunities for settlement are good, and probably 100 intelligent farmers could be placed. The probable number of acres to be irrigated in the vicinity in 1909 is 600, and 4,000 can ultimately be brought under irrigation.

Laredo is the center of a large irrigated area devoted chiefly to onion raising, particularly red and white Bermudas. No detailed information representing conditions at this date could be obtained. There were 1,197 acres of onions in this vicinity in 1908, in tracts of 1 to 44 acres.

The following list is taken from U. S. Geological Survey, Water-Supply and Irrigation Paper No. 71, and from U. S. Department of Agriculture, Office Experiment Stations Bulletin 158, part 6. It covers those systems in Group III, for which data were thus obtainable.

Irrigation systems, Group III.

Company or owner.	Locality.	Source of water.	How introduced into canal.	Lift in feet.	Cost, excluding cost of lands.	Acres cultivated.	Crops raised.
Freeman systems [a]	San Marcos	San Marcos River	Centrifugal pump	26		120	Truck.
Do. [a]	do	do	do	26	$675	10	Do.
Glover system [a]	do	do	do	35		100	Alfalfa.
Lowman system [a]	Staples	do	Undershot water wheel	21		3	Truck.
Jones system [a]	San Marcos	do	Centrifugal pump	31	600	20	Corn and alfalfa.
Landa system [a]	New Braunfels	Comal River	Pumps			70	
Locke system [a]	do	do	do	41		33	Orchards, nurseries, corn, etc.
Lenzen system [a]	do	do	do	60		60	Peas, sorghum, corn, potatoes.
Fischer system [a]	do	Guadalupe River	do	60		50	Corn, grass, gardens.
Breummen system [a]	do	do	do	51		18	
Starty system [a]	do	Well	do	20		8	Cane, corn, cotton.
Dittmar system [a]	do	Guadalupe River	do	40			
Ballard plant [b]	Floresville	San Antonio River	do	47		150	Onions.
Spencer plant [b]	Falls City	do	do	50		15	Corn, onions.
McCay plant [b]	do	do	do	37		26	Do.
Weir plant [b]	Karnes City	do	do	47		110	Corn.
San Pedro ditch [a]	San Antonio	Springs	Ditch			500	
San Juan ditch [a]	do	San Antonio River	do			450	
Espado ditch [a]	do	do	Dam and ditch		3,000		
Kampomay system [a]	do	3 artesian wells	Flows			200	Cane, Johnson grass.
Collins system [a]	do	1 artesian well	do			140	
Brady system [a]	do	do	do			50	
Koelbien system [a]	do	do	do		4,000	21	Truck.
Sewerage farm [a]	do	Sewer system	Pipe line			500	
Comanche Ditch and Irrigating Co. [b]	Batesville	Leona River	Ditch			500	Cotton, corn, oats, grass, and truck.
Alexander farm [a]	Laredo	Rio Grande		65		40	Onions.
Madigal farm [b]	do	do		65		13	Onions, truck.
Nye farm [b]	do	do		65		25	Onions, grapes.
Johnson farm [b]				53		4½	Onions.
Matteson farm [b]	Laredo	Rio Grande	Pump	53		15	Do.
Cogley farm [b]	do	do	do	62		8	Do.
Harrey & Thompson [b]	do	do	do	60		20	Do.
Rio Grande Valley Irrigation Co. [b]	Eagle Pass	do	do	46		300	Cotton, cane, melons, corn, pepper.
Pioneer Rio Grande Irrigation Co. [b]	do	do	do	36		350	Onions, corn, truck, alfalfa.
A. B. Frank ranch [b]	do	do	do	52	20,000	250	Alfalfa.
Fern Lake Ranch Co. [b]	Montell	Nueces River	Dam and ditch			190	Corn, cotton.
Jones ranch [b]	do	do	Pump	27		50	Corn, sorghum.
Baylor ranch [b]	do	do	Dam			25	Johnson grass, cane.

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 71.

[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 158, pt. 6.

Irrigation systems, Group III—Continued.

Company or owner.	Locality.	Source of water.	How introduced into canal.	Lift in feet.	Cost, excluding cost of lands.	Acres cultivated.	Crops raised.
Hargus plant [a]	Cotulla	Nueces River	Pump	36		130	Onions, alfalfa.
Coley plant [a]	do	do	do	40		40	Onions, truck.
Fuller plant [a]	do	do	Pulsometer	35		15	Do.
Goldtrap farm [a]	do	do	Pump	40		101	Cotton, corn, cane.
Gates farm [a]	do	do	do	42½		100	Do.
Seefeld farm [a]	do	do	do	35			Onions, melons, peas.
Kech plant [a]	do	do	do	36		25	Onions.
Taylor plant [a]	do	do	Pump and gravity			175	Onions, corn, cane.
Maney farm [a]	Pearsall	2 wells	Pump	75		9	Onions.
Harkness farm [a]	do	1 well	do	70		4	Do.
Hess farm [a]	do	do	do	75–85		6	Do.
Patterson farm [a]	do	do	do	160		8½	Do.
Trickey farm [a]	do	2 wells	do	60		23	Onions, watermelons.
Berry farm [a]	do	1 well	do	60		7	Onions.
Bennett farm [a]	do	2 wells	do	60		10	Do.
Coker farm [a]	do	1 well	do	110		16	Do.
Little farm [a]	Carrizo Springs	1 artesian well	Flows			16½	Do.
Hughes farm [a]	do	3 artesian wells	do			100	Cotton, corn, and sorghum.
Arnold farm [a]	do	1 artesian well	do			7	Corn.
Shipp farm [a]	do	2 artesian wells	do			30	
Knight farm [a]	do	1 artesian well	do			27	Cotton and grain.
Richardson ranch [a]	do	2 artesian wells	do			400	Corn and truck.
Pollard farm [a]	do	1 artesian well	do			38	Potatoes and truck.
Burton farm [a]	do	do	do			38	Truck.
Jeffrey & Calvan [a]	do	do	do			40	Onions and peas.
Foster place [a]	do	2 artesian wells	do			12	Onions.
Moehrig place [a]	do	do	do			12	Onions and corn.
Owen farm [a]	do	do	do			30	Cotton, corn, cane, and truck.
Kendall place [a]	do	1 artesian well	do			20	Onions and corn.
Oden farm [a]	do	do	do			15	Cotton, corn, cane, and truck.
English farm [a]	do	2 artesian wells	do			48	Broom corn, cotton, and truck.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 158, pt. 6.

GROUP IV.

No recent data regarding the area embraced in Group IV have been obtainable. The following brief description is taken from an earlier bulletin of this Office.[a]

Holliday Creek system.—This system was constructed during the spring of 1901 by J. A. Kemp, of Wichita Falls, who is one of the owners. An earthen dam, about 0.5 miles long and perhaps 25 feet high at the deepest point, served to hold back water covering about 1,500 acres to a depth sufficient for about 13,000 acre-feet. It was expected to irrigate 4,000 or 5,000 acres below the dam, the water being admitted to the main canal by means of iron gate valves set in two cast-iron pipes which pass through the dam, the pipes having concrete collars at the joints to prevent water from following along the outside of the pipes. This dam was exceptionally well constructed, but because of prairie-dog holes, which were not discovered during construction, a portion of the dam was carried away on May 18, 1901. This was rebuilt afterwards and the water conserved by the dam has since been used for irrigation. Use is made of it also for supplying the waterworks system of the town of Wichita Falls. How successful the enterprise has proven can not be stated, nor can it be stated what the character of crops grown may be, nor the amounts and values of same. The dam and lake were more or less experimental, with a view of proving whether or not a much larger system could be made profitable. It was proposed to locate this larger system on the Wichita River, at a point perhaps 40 miles above the town, the water to be impounded by means of an earthen dam 100 feet high, and the lake to have a storage capacity of 200,000 acre-feet. It was proposed to irrigate lands on both sides of the river, down to its junction with the Red River. As several counties would have to be crossed, and as there was no statute in force at that time which would cover the formation of such an irrigation district, a constitutional amendment was proposed to admit of this being accomplished in this particular case. This amendment was submitted to popular vote, but failed to carry, with the result that the system still remains a mere project. Still another system having a dam and reservoir on the Brazos River was proposed at one time, the object being to lead the water through a low portion of the divide between the Brazos and the Wichita drainage areas and to irrigate a large acreage on the latter drainage. This failed to materialize also, but both these systems seem feasible, provided the problem of silt, as it may affect the storage capacities of the lakes, can be properly dealt with.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 119, pt. 4.

GROUP V.

The areas in the vicinity of Junction, Menardville, San Saba, Lampasas, San Angelo, Abilene, and other towns are embraced in Group V, but detailed descriptions of only a few of the irrigated farms could be secured.

The Moore farm.—This farm is situated 2.5 miles east of San Saba and is owned by S. M. Moore and managed by J. H. Moore. Water is pumped from the San Saba River by means of a 6-inch centrifugal pump run by a 20-horsepower gasoline engine, against a 30-foot lift. The cost of construction was $1,200 and the cost of running the engine $3.75 for ten hours. Gasoline cost 14.5 cents per gallon in 1908. The canal is three-fourths mile long over nearly level ground. The cost of construction was very small, being estimated at $150, and the annual cost of maintenance the same amount during the irrigating season, the maintenance consisting of cleaning out grass and weeds. The irrigation season is six months. Ninety acres were in cultivation in 1908, probably 115 in 1909, and eventually there will be 150 acres on this canal. Unimproved lands in the vicinity are worth $25 per acre, while irrigated land is worth $60. It costs $10 per acre to prepare the land for irrigation and the crops grown are corn, cotton, potatoes, onions, watermelons, and tomatoes. These are marketed in San Saba and surrounding towns. Corn produces 60 bushels per acre at a cost of $15; cotton, 1 bale, at a cost of $27; potatoes, 200 bushels, at a cost of $40 per acre. The corn is valued at $30, cotton at $40, and potatoes at $200, leaving profits of $15, $18, and $160. One man can manage 40 acres of corn, 30 acres of cotton, and 10 acres of potatoes, and the cost of the outfit for 100 acres is estimated at $500. Opportunities are good for American and German settlers; it is estimated that 15,000 acres can be irrigated in this vicinity.

Thomas Hawkins's farm.—Mr. Hawkins pumps water from the San Saba River, 7 miles west of San Saba, against a lift of 32 feet, by means of a 6-inch centrifugal pump operated by a 12-horsepower gasoline engine. Four to 6 acres can be irrigated per day, the cultivated land being favorably situated for the purpose and lying quite close to the pump. Corn was watered twice during the season of 1908, 25 acres of corn yielding 60 bushels to the acre. It was estimated that 30 acres of irrigated cotton yielded 1 to 1.5 bales per acre. The cotton received two waterings also during the season. On unirrigated cotton lands it was estimated that the yield would be 0.50 to 0.25 bale per acre. The pumping plant was installed in February, 1903, at a cost of $900. The cost of the gasoline was considered the only maintenance charge, as the farmers do all the work themselves. It was estimated that gasoline at 14.5 cents per gallon during 1908 would amount to 45 cents an acre, as against 70 cents during 1907.

Mr. Hawkins does not consider that trucking will pay in that section, because of the distance from market and the scarcity of labor.

Miller Brothers farm.—At Lampasas, water from Sulphur Creek and from a well is utilized to irrigate about 40 acres. There is a 6-inch centrifugal pump located on the creek and 1,000 gallons per minute are pumped against a lift of 25 feet. In the well, on the creek 1,000 yards from the pump, a 5-inch centrifugal pump is installed, which lifts the water 35 feet and delivers 250 to 300 gallons per minute. Both pumps are run by a 15-horsepower portable engine, using naphtha for fuel. The total cost of both plants was $1,200. The main canal is 800 yards long, has a cross section of 4 square feet, and will deliver 1,000 gallons per minute. Its cost was $75. The cost of maintaining canals and laterals is $25 per annum. The furrow system of irrigation is used and the irrigation period lasts six months. From 4 to 24 inches of water are applied per season, depending upon the kind of crop and the rainfall, which is estimated to be 5 to 15 inches during the irrigation season. Forty acres were under cultivation in 1908, and it will be the same for 1909; only 60 acres can be served by this canal. Unimproved lands before irrigating are valued at $40 per acre, while those under irrigation are valued at $100. It is estimated that it costs $5 per acre to prepare the land for irrigation. The crops grown are cotton, corn, sweet potatoes, Irish potatoes, tomatoes, onions, and melons. These are marketed in Lampasas. Corn yields 40 bushels per acre; cotton, 1 bale; sweet potatoes, 300 to 400 bushels. It costs $15 to $150 per acre to produce and market the crop, depending upon the kind of crop grown, and the average value of the crop varies from $30 to $300 per year for the same reason. The net returns per acre from sweet potatoes is from $100 to $200; cotton, $25; corn, $15; onions, $150 to $200; and Irish potatoes, $50 per acre. With help in harvesting, one man can handle 10 acres of sweet potatoes, 15 acres of Irish potatoes, 40 acres of corn, 40 acres of cotton, and 5 acres of onions. It is estimated that to install a pumping plant for 10 acres and to purchase team and tools, together with running expenses, would require $2,000. The opportunities for settlement are good and perhaps 50 families could be provided room. One hundred and fifty acres will be irrigated in the vicinity in 1909, and the ultimate irrigable area is estimated at 1,000 acres.

The San Jose Irrigation and Power Company.—This company diverts water from Dove Creek at Knickerbocker by means of a brush and rock dam which cost $200 to construct and $100 per year for repairs. This is owned jointly by the landowners along its line, and irrigation is used to supplement the rainfall. From 6 to 8 cubic feet per second is carried by the canal and 1,500 acres could be irrigated if the water supply were sufficient. The main canal is 5 miles long

and the laterals 2 to 3 miles long. The canal slopes 2 to 3 feet per mile and the laterals 3 or 4 feet. The cost of construction is unknown, but the annual cost of maintenance is $100 to $200. The lands are irrigated once every two weeks and the rent for same is included with land rent. The irrigation period lasts from March 1 to October 1, and sometimes grain and alfalfa are irrigated in winter. It is estimated that a depth of 12 inches of water is applied per irrigation. One thousand acres were irrigated in 1908 and the same acreage for 1909, but 1,500 acres could be brought under canal. The present value of unimproved lands is $10 to $15, but before irrigating it was only about $5. Irrigated lands are valued at $50 per acre and the cost of preparing land for irrigation is $10 per acre. The crops and average yields are stated as follows: Alfalfa, 3 to 4 tons; Johnson grass, 2 tons; corn, 40 bushels; cotton, three-fourths bale; oats, 40 bushels. Garden truck yields were not obtainable. The average values of the crops are given: Alfalfa, $50 per acre; Johnson grass, $20; corn, $20; cotton, $35, and oats, $16. It is estimated that one man can care for 20 acres, but there are no opportunities for additional settlers in the immediate vicinity, as no prospect for additional irrigated areas is in sight on account of lack of water.

C. B. Metcalfe, of San Angelo, does not describe his irrigation system in detail, but he irrigates 200 acres at the Gardner dam. He gives a general description of the methods used in diverting the water upon the land and information as to values, etc., and follows with a list of irrigators and acreages in the San Angelo region in 1908. The following is an abstract of his general description: The systems listed as being on the South Concho and Dove creeks are in Tom Green County; those on Spring Creek at Sherwood are in Irion County. Water is diverted from these streams by means of dams built of rock and of concrete. The head gates are set in simple rock abutments, the gates being of wood. The cost of maintaining these is small and the cost of dams, headworks, and ditches will approximate $8 per acre irrigated. Pumping plants consist of centrifugal pumps varying in size from 6 to 10 inches and working against lifts which vary from 20 to 40 feet. In the main they are driven by gasoline engines, but a few steam engines are used. The canals average 7 feet wide and are 3 feet deep, though cuts as deep as 8 feet exist in places. The depth of water will average 2 feet, and the general fall is 3 feet per mile. The canals vary in length from 1.5 to 5 miles and in general follow the edges of the hills, so as to command the areas lying between them and the streams. The cost of maintaining and cleaning canals will average $2 per acre irrigated per annum. No measurement of water is made and farmers receive water in rotation. The average water rental is $3 per acre, and the irrigation season lasts from March to

September. Water is turned on the lands five times per season for field crops and seven times for truck. The average rainfall during the irrigation season is estimated to be 16 inches. The area irrigated during 1908 was 6,200 acres and there will be no increase during 1909. A large additional acreage could be irrigated if the water available were not already appropriated. Storage reservoirs could be constructed, however, and thus the acreage would be greatly increased.

Unimproved lands are worth $20 per acre and the cost of bringing the land under irrigation averages $10 per acre, after which the land is worth $30 to $200 per acre. The crops grown, with their average yields, are as follows: Cotton, 1 to 1.5 bales; corn, 40 bushels; oats, 65 bushels; alfalfa, 4 tons; truck (all vegetables, celery, and melons), about $150 per acre. The cost of producing some of these crops is given as follows: Hay, $4 per ton; cotton, 5 cents per pound; truck, $100 to $150 per acre. The average area which one man can handle is stated as 10 to 40 acres, and for this, in addition to the first cost of the land, $1,500, he would need for other improvements and maintenance for one year $3,500. The opportunities for settlement are good for dairy, truck, and hog farmers, cotton growers, etc. Probably 5,000 responsible white farmers could find good homes. Mr. Metcalfe adds that irrigation has not been very profitable on the large farms on account of the lack of good labor and the high prices. Small tracts have paid well, truck lands yielding $50 or more per acre, net, and alfalfa as much as $40, net. The small farmers do well, and fruit and celery can be very profitably grown in the valleys. The country is a rolling limestone formation and one of the most healthful in the United States. The elevation is 2,000 feet and upward. There are many good springs and an abundance of excellent underground water.

The following list of irrigation systems falling under Group V was compiled from U. S. Geological Survey, Water-Supply and Irrigation Paper No. 71, except as shown in footnotes:

Irrigation systems, Group V.

Owner or company.	Locality.	Source of water.	How introduced into canal.	Lift in feet.	Length of main canal.	Cost exclusive of lands.	Acres cultivated.	Crops raised.
Byers systems	Menardville	San Saba River	Dam					Grapes.
Wilkinson system	do	Clear Creek	do				12	Corn, cotton, oats, etc.
Striegler system	do	do	do				18	Do.
Noyes system	do	San Saba River	do				2,000	
J. C. Petmecky [a]	do	do	do					
Kitchen ditch	do	do	do		4½ miles		300	
Vanderstrucken system	do	do	Pump	31		$1,500	1	
Sloan system	Sloan	Springs	Dam				186	Corn, cotton, cane, potatoes.
Doran system	San Saba	San Saba River	Pump	28			100	Do.
West & Burnett	do	Drain	Dam			1,000		Ordinary crops.
King system	do	Springs					40	Do.
Ellis system	do	Well	Pump	25				Do.
Hawkins system	do	do	do	33		825	50	Do.
Maxwell system	do	Springs			1,500 feet		40	Onions, corn, etc.
Baker system	Sloan	Richland Spring	Dam	20	2 miles		150	Cotton.
Finland system	Lampasas	Lampasas River	Dam and pump				15	Truck.
Swinder Pecan Orchard Co.	Brownwood	Pecan Bayou	Reservoir and pump				55	Pecans.
Fairland farm	do		Pumps			5,000	400	Cotton.
Williams or Joe Glenn ditch	Water Valley	North Concho River	Dam		3 miles		225	Cotton, sorghum, oats.
Glenmore ditch	San Angelo	South Concho River	do		4 miles	6,000	110	Celery, alfalfa.
Bismark ditch	do	do	do		do	5,000	600	Oats, corn, cotton, hay.
Gardner system	do	do	do		2 miles	900	70	Do.
Twin Mountain ditch	do	do	do		3 miles	2,500	300	Do.
Metcalfe ditch	do	do	do		4 miles	3,300	470	Oats, corn, and cotton.
South Concho Irrigation Co.	do	do	do		3 miles	1,800	220	Oats, hay.
San Jose Irrigation Co.	Knickerbocker	Dove Creek	do		6 miles	3,000	1,400	Oats, corn, cotton, sorghum.
Baze ditch	do	do	do		3 miles		160	Oats, alfalfa, cotton.
Kelley system	San Angelo	Lepan Creek	do		1½ miles	450	40	Oats, hay, truck.
Moos system	Junction	Johnston Fork of Llano River.	do		¼ mile		18	Oats, wheat, potatoes, truck.
Rembold system	do	do	do		900 feet	85	4	Truck. Johnson grass.
Long system [b]	do	do	Pumps operated by water wheel.		600 feet	340	5	Truck and sorghum.
Armstrong system	do	do	Dam			1,200	65	Alfalfa.
Allen & Kelly system	do	Cedar Creek	do		¾ mile		20	Wheat, oats, corn.
Jarvis Hodges	do	do	do		800 feet		44	Corn, potatoes, etc.
Taylor place	do	do			2 miles	325	7	Do.
Jenson system	do	Bailey Creek	Spring				5	Corn, cane.
Dupuy system	do	Kyac Creek	do				7	Do.
Griffith system	do	do	Dam				16	Corn, wheat, truck.
Bishop system	do	do				160		Corn, cane, cotton.
Calentine system	do	do				105	25	Corn.

Flemming system	do	Flemming Branch			½ mile	100	35	Corn, oats, alfalfa, truck.
Baldwin system	do	South Llano River	Spring				2	Corn, cane.
Taylor system	do	Christmas Spring	do				25	Do.
Barrett & Stephenson system	do	Springs	do			200	25	Corn, cane, wheat.
Huffman system	do	do	do		300 feet	75	7	Corn.
Hall system	do	East Bear Creek	Dam		½ mile	400	10	General crops.
Reid system	do	West Bear Creek	do		do	60	8	Do.
Stewert system	do	do	do			200	30	Do.
Morales system	do	do	do		¾ mile	275	10	Do.
L. C. Pasture system	do	do	do		¼ mile	75	8	Alfalfa.
Meng system	do	Walnut Creek					1	Truck.
Gordon system	do	North Llano River	Pump	35		1,800	35	Corn, alfalfa.

[a] Listed in U. S. Geol. Survey, Water-Supply and Irrigation Paper No. 71 as Sieker system.
[b] Sold to J. J. Bullard.

GROUP VI.

The Pecos and Toyah valleys and Fort Stockton regions are embraced in Group VI.

Zimmerman irrigated lands.—Mr. D. Zimmerman, of Kansas City, Mo., owns 27 alternate sections of land in the Pecos Valley and is constructing a canal which has the intake 3 or 4 miles below a point opposite Grand Falls. The canal will follow pretty close to the Pecos River, but, except for a map in the printed prospectus issued with the view to selling lands, no data could be obtained. This prospectus states that lands are offered for $30 per acre on easy payments, and that there will be no charge for water to purchasers now or at any future time. The canal is now under construction and will not be ready to deliver much water during the season of 1909. It is situated on the right bank of the Pecos River, between the river and the canal system to be described next.

The Imperial Canal.—This canal is being projected by the land department of the Kansas City, Mexico and Orient Railway Company. The company has purchased the canal and rights of the Pecos River Irrigation Company and will repair the headworks and a portion of the canal through which to furnish water to the new system. The dam, built of rock and brush, is located in the river 28 miles below Pecos city. From here the old canal will be used for some distance, but farther south the new one will leave it and run to a reservoir. This reservoir is mostly a natural depression on rather commanding ground, and by constructing a low levee on the south end, about 15,000 acre-feet of storage capacity can be secured. From the reservoir the canal will follow a grade contour south and east for 20 miles, and will cover, if water proves available, 100,000 acres of land lying between it and the river. The land under this canal is very uniform, has good slopes for irrigation, and the soil is a dark, rich, silty loam, capable under careful irrigation and thorough cultivation of producing large returns. It is the purpose of the company to use the stored water to furnish the supply during times of shortage only, the principal drought occurring in March and April.

The Grand Falls Land and Irrigation Company.—A brush and stone dam, 150 feet long and 12 feet high, diverts water from the left bank of the Pecos River at Grand Falls; the cost of the dam was $3,500. The main canal is 40 miles long, has 16 feet bottom and 1.5 to 1 side slopes, and falls 1.5 feet to the mile. It cost $1,000 per mile. There are 100 miles of laterals, with bottom widths of 6 to 10 feet, side slopes 1.5 to 1, and the cost of construction varied from $250 to $500 per mile. The annual cost of maintaining canals and laterals is $5,000. Water is not measured, and the land is flooded to a depth of 4 inches to 2 feet at each watering. This excessive

use of water is rapidly destroying the fertility of the land. The rental rate is $1.25 per acre, and irrigation lasts all the year. There were 7,500 acres under cultivation in 1908; it was expected that 8,000 acres would be irrigated in 1909, and the ultimate acreage which this canal can serve, if sufficient water is available, is placed at 30,000 acres. Unimproved land before irrigation was valued at $1.50 and is now valued at $10, while land under irrigation is valued at $50 to $100 per acre. Extra heavy yields of alfalfa, cotton, milo maize, oats, barley, corn, and grapes are obtained from this irrigated land. The value of the yield from an acre of cotton is placed at $50; corn, maize, and oats at $30; alfalfa, $60; and grapes, $500. These are marketed at Monahans, on the Texas and Pacific Railway. The equipment needed for each 40 acres is estimated at $400, and one man is supposed to care for 50 acres of cotton, or 40 acres of alfalfa, or 10 acres of grapes. The average per man is put at 40 acres, and if industrious the beginner can make a start on $1,500. The opportunities are good for 500 families of new settlers.

The Barstow Land and Irrigation Company.—This canal was begun by George E. Barstow, in 1892 or 1893, and diverts water from the right bank of the Pecos River by means of a brush dam situated about 7 miles above the town of Barstow, the inflow to the canal being regulated by a simple wooden head gate. Three miles below the headworks the main canal crosses the Pecos River by means of a wooden flume, and one lateral follows down the west side of the river, watering 800 acres in 1908. The main canal on the east side extends 9 miles down the valley, with many laterals, and in 1908 watered 8,000 acres. The main canals and laterals approximate 70 miles in length. The main canal has a width of 20 feet at bottom, 2 to 1 side slopes, and is 4 feet deep. The grade is 1 foot per mile. The ultimate area which can be served, if sufficient water is available, will approximate 25,000 acres.

Alfalfa and cotton form the principal crops, but in 1908 there were about 200 or 300 acres of milo maize under irrigation and 300 acres in peach and apple orchards and in vineyards.

The town of Barstow was founded in 1894 and has a population now of approximately 1,000, while the whole population supported by the canal system, including the town, is 2,300. Improvements in the water supply of the town are now being made, and an extensive drainage system, under provisions of the new drainage law, is in process of preparation. Land with water right sells at $40 to $100 per acre, and when under cultivation for $60 to $150. The Pecos Valley soil is composed of rich, heavy, black silt for a distance of perhaps 3 miles from the river to the east and 1 mile to the west. Back from the river from 1 to 3 miles the land begins rising quite

rapidly and the surface soil is underlaid at a depth of 1 to 3 feet with a rotten limestone gypsum rock. Elberta peaches, apples, and European grapes, quantities of cantaloups, plums, truck, alfalfa, milo maize, and cotton are grown, bringing large profits when properly cared for.

Irrigation from springs around Fort Stockton.—At Fort Stockton, the county seat of Pecos County, 30 miles west of Grand Falls, springs unite to form Comanche Creek, which has a total discharge of 60 to 70 cubic feet per second, sufficient for 10,000 acres. On 7-D ranch there was irrigated in 1908, 900 acres in Johnson grass. Though the soil of this ranch is a rich silt loam, it produces but small return on account of the very slack methods used in irrigation and cultivation.

Mr. James Rooney irrigated from these springs about 700 acres in alfalfa, corn, and fruit during 1908, and could irrigate much more, as there is plenty of water for a larger acreage, and he expects to increase the area under irrigation to 2,000 acres in 1909. On the 7-D and Rooney ranches a total of 10,000 acres can be irrigated.

J. H. Crawford irrigated 500 acres in 1908 from San Pedro springs, of which 300 acres were in alfalfa, 100 in milo maize, and 100 in corn, truck, etc. He let 200 acres of his second crop of alfalfa go to seed and thrashed 225 pounds of seed per acre, which, at the present price of such seed, is worth $6,750 gross. In addition to this, the straw remains, besides the hay from the first cutting and probably two more after the crop of seed. Alfalfa brings $10 per ton and averages 1 ton per acre to the cutting. By proper cultivation with a disk renovator after each irrigation the yield is increased and alfalfa then needs to be replanted only once in ten or twelve years.

The Fort Stockton country has a rich chocolate loam soil, 2 to 10 feet deep, and contains a large percentage of organic matter. There is sufficient water supply in that region to irrigate about 10,000 acres.

The Toyah Valley Irrigation Company is located at Brogado, Reeves County. The valley, hemmed in by a horseshoe-shaped curve of the Davis Mountains, is a flat which is watered by springs which unite to form Toyah Creek. The valley is 40 miles southwest of Pecos, and 30 miles from Toyah station on the Texas and Pacific Railway. Seven thousand acres are watered from the San Solomon, Saragossa, San Dio, and Little Giffin springs, of which 1,200 acres are in alfalfa, 2,000 in cotton, 275 in orchards and vineyards, and 3,500 in corn, milo maize, Kafir corn, sorghum, oats, and truck. There are 14 miles of main canal, 6 feet wide on the bottom and 1 to 1 side slopes. The longitudinal slope is 46 feet to the mile, but a layer of soft magnesium limestone in the bottom prevents washing. It is planned to use this fall for the development of water power. Eight

miles below the main spring a concrete dam 8 feet high intercepts seepage water returned to the creek and furnishes 10 cubic feet per second, which is used in irrigating lower down the valley. The soil of Toyah Valley is of four classes: Light sandy, dark sandy, chocolate loam, and black loam. The chocolate loam and the light sandy soil predominate, but all are very rich. There are large areas of this valley which are available for irrigation, provided sufficient water can be conserved by storage reservoirs. On an average alfalfa is cut six times per season, averaging 1 ton to the cutting, and its value is $10 per ton. Mr. Giffin, who had 35 acres in pear orchard in 1908, states that the previous year he cleared $900 per acre on Kieffer pears.

GROUP VII.

Group VII covers the Rio Grande Valley in the vicinity of El Paso and as far down the river as Presidio and Brewster counties.

Franklin Irrigation Company.—This company owns and operates the principal system in the El Paso Valley. Water is diverted from the Rio Grande just above El Paso, and the main canal is 28 miles long, 20 feet wide at the bottom for a distance of about 5 miles from the intake, after which it decreases to 16 feet bottom width. The side slopes are 2 to 1, the depth 4 feet, and the capacity at the intake 300 cubic feet per second. The company owns no laterals, as the consumers are required to construct those which are necessary to reach their lands. This system covers 5,000 acres, planted to alfalfa, grain, fruits, and vegetables. The water rental is $3 per acre for truck and $2 per acre for other crops. The canal system is divided into 4 sections of 7 miles each, and a tender is assigned to each section whose duty it is to distribute the water by rotation, making a round once in ten days.

Socorro and San Elizario ditches.—These are community canals, each serving 1,600 acres. On account of the changes in the river they are not able to receive water from the river at all times, but in case of shortage from this source they draw water from the Franklin Canal. The crops grown are the same in character as those cultivated on the Franklin system. The soil of El Paso Valley varies from a fine thick sand to a heavy silty clay, rich in mineral plant food but lacking in humus. On account of the altitude—3,500 feet above sea level—the clays under proper handling are especially well adapted to the production of fruit, particularly the Bartlett pear. In the valley alfalfa yields 5 to 10 tons, which is worth $10 per ton; wheat produces 30 to 40 bushels to the acre; sweet potatoes yield 300 bushels to the acre and are worth 2 cents per pound; Bartlett pears yield 500 to 600, occasionally as many as 1,000, 50-pound boxes, worth $1 to $1.50 per box, and the net returns vary from $200 to $500 per acre.

The limits of El Paso extend 4 to 5 miles east of the main portion of the city, and within these limits land for irrigation and other purposes sells as high as $1,200 per acre. From 6 to 10 miles down the river the land sells for $100 to $150 per acre, and 10 to 12 miles below El Paso it sells for $100 per acre. The present irrigated area, together with a large additional acreage, amounting in all to 45,000 acres, will come under the Rio Grande project of the Reclamation Service. This system of canals is now under construction.

The following systems, situated in the Big Bend of the Rio Grande, are mentioned in a publication of the U. S. Geological Survey.[a]

Systems in the Big Bend of the Rio Grande.—The Candalereia ditch takes water from the Rio Grande at a point 45 miles from Shafter, when there is water in the river; but ordinarily the canal is fed by Coyote Creek and 200 acres are served.

The Dawson system, at Shafter (G. S. Dawson, owner), utilizes a strong spring to irrigate a small area.

Del Rosa ditch takes water from the Rio Grande, using a low diversion dam for the purpose. One thousand two hundred acres are irrigated.

The Palvo Irrigation Company has a small diversion dam about 10 miles above Presidio. No acreage is given.

The Ernst and Lindsey systems are 2 small private ditches, situated near Boquillas on the Rio Grande, in Brewster County. No acreage was given for the first system, but the latter had 30 acres in beans and corn in 1902.

Alamo and Leoncito Creek systems, on Alamo Creek, in Brewster County, were in operation in 1902, the first of which served 250 acres in corn, beans, wheat, and sorghum in 1902. Three small ditches, irrigating 3 acres each, are mentioned as being taken from Leoncito Creek.

The Pool ditch, near Shafter, was used to irrigate 5 acres in vegetables and fruit in 1902, the water being derived from springs.

The Hoosier Brothers' ditches, near Dryden, were used by Hoosier Brothers to irrigate 24 acres with water derived from a spring.

Jeff Davis County ditches, along Limestone Creek, irrigated 100 acres in farms and gardens in 1902.

Templeton system, 13 miles northwest of Alpine and 15 miles southeast of Fort Davis, irrigates an 18-acre orchard, the water being derived from 2 springs. Two miles above the Templeton ranch a field of hay was irrigated directly from springs without the use of ditches; 30 acres were served.

The above data are six years old.

---

[a] U. S. Geol. Survey, Water-Supply and Irrig. Paper No. 71.

LAWS GOVERNING THE CONTROL AND USE OF WATER.

On February 10, 1852, the fourth legislature of the State of Texas passed an act (title 55, chapter 1, Irrigation, Revised Statutes, articles 2982 to 2988) giving to commissioners' courts the right to regulate irrigation and the manner of constructing irrigation systems and appurtenances when the same were situated outside of a corporation having jurisdiction over them. Further authority to establish police regulations and to impose fines for abuse of systems, etc., was given by the same act. Further authority to lease any lot or subdivision on an irrigation system was given in case of delinquency on the part of any owner who failed to pay his proportion of labor and expense for any part of construction or maintenance of the system. The commissioners' courts were also authorized to license private enterprises and to permit the damming of streams and construction of canals for the purpose, provided that "the assurance and the proper security (be) given to the county, if required by said court, that no injury will result to the public health," and providing for suits for injuries to other parties by reason of the construction of the particular irrigation system. The commissioners' courts were authorized also to permit the condemnation of the necessary property over which canals, which in their judgment were of sufficient importance, would pass, or for the construction of the necessary dams, etc. In case of injury to the public health by reason of lakes or other standing water, the commissioners' courts were empowered to order the discontinuance of any irrigation system causing such injury. The courts were authorized also to establish such fence laws as were deemed necessary in the several districts.

On August 21, 1876, the fifteenth legislature passed an act granting to any "person, firm, or corporation who shall construct a canal or ditch for navigation or irrigation, in accordance with the provisions of this chapter," grants of public lands, as follows: For a canal of the first class, which is defined as one carrying a stream of water of a uniform width of 30 feet and uniform depth of 5 feet, 8 sections of land—5,120 acres—for each mile of canal constructed; for the second class, those carrying a stream of water of a uniform width of 15 feet and having a uniform depth of 4 feet, 6 sections per mile; for the third class, those carrying a stream of water of the uniform width of 9 feet and a uniform depth of 3 feet, 4 sections to the mile. Canals or ditches not complying with the conditions of the third class, but carrying streams of water of a uniform width of not less than 6 feet and having a uniform depth of not less than 2 feet, were put in a fourth class and for their construction grants of 2 sections per mile of canal were allowed. Canals for navigation having a width of 40 feet and a permanent depth of 4 feet were granted 16 sections per

mile. (Note that no mention is made of the carrying capacity of any one of the four classes of irrigation canals or ditches named.)

Under the terms of this act the governor was charged with the appointment of an inspector of canals, whose compensation was fixed at $25 per mile of canal inspected, which was to be paid by the firm or corporation doing the building. The builder was required also to furnish a bond to the commissioner of the general land office of the State that the canal would be maintained in good condition for ten years.

The foregoing is covered in articles 2989 to 2995, inclusive, which articles, together with article 3001 providing that no subsidy should be given for unnecessary ditches, were repealed by an act of the seventeenth legislature on April 22, 1882. This act also repealed all laws or parts of laws granting subsidies for the construction of railroads. Articles 2996 to 3000, inclusive, of the act of August 21, 1876, remain in force. These effective articles gave to irrigation or navigation companies a right of way not to exceed 100 feet in width over all public, university, school, and asylum lands, and the use of necessary rock, gravel, and timber for construction purposes. Also the right to cross private lands by contract with the owner, or by condemnation proceedings. The legislature reserved the right to control the rates for freight and passage and for the water supply of cities and towns. It gave also to such companies the free use of the waters of the rivers and streams of the State, but held the companies responsible to injured owners for all damages resulting from the construction of the navigation or irrigation canal. The right to cross highways when necessary was given also, but the constructing companies were required to construct and maintain all necessary bridges for the accommodation of the public.

By acts of March 19 and July 6, 1889 (chapter 3, title 55, Irrigation, Revised Statutes) the diversion of unappropriated running water was authorized when found necessary for irrigation, provided riparian owners were not thereby deprived of water for domestic purposes. Provision was made for the appropriation of public streams for irrigation, and provided for the forfeiture of the right whenever the water was no longer used for this purpose. Regarding priority of right the act states: "As between appropriators, the one first in time is the one first in right to such quantity of the water only as is reasonably sufficient and necessary to irrigate the land susceptible of irrigation on either side of ditch or canal." The process of appropriation was very simple and consisted in filing with the county clerk a sworn statement setting forth the name of the canal, location of headgate, cross section, and capacity of the ditch, the name of the stream from which the water was to be taken, time of beginning work, and the names of the owners, together with a map showing the location

of the canal. The result was the filing of some remarkable documents, some of which claimed several times the total discharge of the streams upon which the canals were to be located, and even stated the discharging capacity at so many "square feet every second." Fortunately, a number of these projects never made any substantial progress beyond the filing of the documents. Others necessarily proved failures. The time of beginning construction was fixed at ninety days from the filing of the statement, and by compliance with the provisions of the act the claimant's right to the use of water dated back to the time of beginning construction. It was made unlawful for subsequent claimants to deprive prior claimants of the use of water except for domestic purposes.

Authority was given for the formation of irrigation companies under the general incorporation laws of the State, and as much as 100 feet width of right of way was granted across all public, university, school, and asylum lands, and condemnation proceedings authorized for the acquisition of right of way across private lands. It was provided that all unused water should be conducted back to the original stream and a crude method of providing for the sale of water was described. The right of the legislature to control the diversion and distribution of water was reserved, this right to be applied either by direct legislation or by the creation of a water commission having full delegated powers.

The right to cross or run along roads and highways was given and it was a misdemeanor for any person to injure any irrigation canal, well, or appurtenance, or to waste the water therefrom or use it without authority. Irrigation corporations were given the right to acquire land either by purchase or donation, or in payment of stock or water rights and to dispose of this at will, and to borrow money, in security for which mortgages on the property of the company would be legal. Also the right to issue bonds was given. It was provided, however, that all lands acquired by such a company, except such as were used for the construction and maintenance of the system, should be alienated within fifteen years of their acquisition or be subject to judicial forfeiture. All conflicting laws or parts of laws were repealed by this act.

The following discussion of the legislative act of 1895 was prepared by Judge W. H. Wilson, of Houston, whose experience in connection with litigation affecting irrigation renders him especially well prepared to emphasize the essential features of the legal status of irrigation in Texas:

The most important statute in the State of Texas is found in chapter 2, title 60, of the Revised Statutes: Article 3115 declares the unappropriated waters of the ordinary flow or underflow of every flowing river or natural stream and the storm or rain waters of every river or natural stream, canyon, ravine, depression, or water-

shed within those portions of the State of Texas, *in which by reason of the insufficient rainfall or by reason of the irregularity of the rainfall irrigation is beneficial for agricultural purposes* to be the property of the public and subject to appropriation for the uses and purposes named in the statute. By articles 3116 and 3118 it is provided that such waters may be appropriated for the purposes of irrigation, mining, milling, and construction of waterworks for cities and towns and stock raising in such sections of the State. By article 3117 it is provided that such waters shall not be diverted for the purposes named "to the prejudice of the rights of the riparian owner without his consent, except after condemnation thereof in the manner provided in the act." By article 3119 it is provided that as between the appropriators, the first in time is first in right.

By article 3120 it is provided that "every person, corporation, or association of persons who have constructed or may hereafter construct any ditch, canal, reservoir, dam, or lake for the purposes named in this chapter, and taking the water from any natural stream, storage reservoir, dam, or lake, shall within ninety days after commencement of such construction, file and cause to be recorded in the office of the county clerk of the county where the head gate of such ditch or canal may be situated or to which said county may be attached for judicial purposes, in a well-bound book to be kept by said clerk for that purpose, a sworn statement in writing showing approximately the number of acres of land that will be irrigated, the name of such ditch or canal, the point at which the head gate thereof is situated, the size of the ditch or canal in width and depth, and the carrying capacity thereof in cubic feet per second of time, the name of said stream from which said water is taken, the time when the work was commenced, the name of the owner or owners thereof, together with a map showing the route of such ditch or canal; and when the water is to be taken from a reservoir, dam, or lake, the statement above provided for shall show in addition to the ditch and other things provided for, the locality of the proposed dam, reservoir, or lake, giving the names or numbers of the surveys upon which it is to be located, its holding capacity in cubic feet of water, the acreage and surface feet of land that will be covered, and the limits of such lake, reservoir, or dam, and the area of the watershed from which the storm or rain water will be collected."

Article 3121 provides that by compliance with the provisions of article 3120 the claimant's right to the use of the water relates back to the time when the work of excavation of construction commenced.

Article 3122 provides that "any person, firm, association of persons, or corporation may acquire the right to appropriate for irrigation purposes the unappropriated waters of the ordinary flow or underflow of every running or flowing river or natural stream, and the storm or rain water of every river or natural stream, canyon, ravine, depression, or watershed within those portions of the State referred to in article 3115, by filing a sworn statement in writing to be recorded as provided in article 3120, declaring his or its intention of appropriating such water. Said statement shall also show approximately the number of acres of land proposed to be irrigated, the name of such ditch or canal, the point at which the head gate thereof will be situated, the size of the ditch or canal in width and depth, and the carrying capacity thereof in cubic feet per second of time, the name of the person, firm, association, or corporation appropriating such water, the name of the stream, and shall attach to such statement a map showing approximately the proposed route of such ditch or canal; and when the water sought to be appropriated or acquired is storm or rain water, the statement above required shall show or describe also the locality of the proposed dam, reservoir, or lake by giving the names or numbers of the surveys upon which it is to be located, and approximately the following, that is to say, its holding capacity in cubic feet of water, the acreage of land that will be covered, and the area of the watershed from which the storm or rain waters will be collected; provided, any person, association of persons or corporation who has heretofore had a survey made of the proposed route

of his or its ditch shall have a preference right at any time within ninety days from the time this chapter shall take effect to file the statement hereinbefore required for the appropriation of water. Within ninety days next after filing of said statement the party or corporation claiming the right to appropriate the water shall begin actual construction of the proposed ditch, canal, dam, lake, or reservoir, and shall prosecute the work thereon diligently and continuously to completion."

Article 3123 provides that by "completion" is meant the conducting of the water in the main canal to the place of intended use. Article 3124 provides that the person or corporation who has appropriated such waters in accordance with the statute shall be entitled to the exclusive use except that an owner whose land abuts on a running stream may use such water therefrom as may be necessary for domestic purposes, and except that a person owning land on the watershed from which the waters were collected may construct such dams, etc., as are necessary for the storage of water for *domestic* purposes. By article 3125 it is provided that—

"Corporations may be formed and chartered under the provisions of this chapter and of the general corporation laws of the State of Texas, for the purpose of constructing, maintaining, and operating canals, ditches, flumes, feeders, laterals, reservoirs, dams, lakes, and wells, and of conducting and transferring water to all persons entitled to the same for irrigation, mining, milling, to cities and towns for waterworks, and for stock raising, and for the purpose of building storage reservoirs for the collection and storage of water for the purposes before mentioned. All such corporations shall have full power and authority to make contracts for the sale of permanent water rights, and to have the same secured by liens on the land or otherwise, and to lease, rent, or otherwise dispose of the water controlled by such corporation for such time as may be agreed upon, and in addition to the lien on the crops hereinafter provided for, the lease or rental contract may be secured by a lien on the land or otherwise. All persons who own or hold a possessory right or title to land adjoining or contiguous to any canal, ditch, flume, or lateral constructed and maintained under the provisions of this chapter, and who shall have secured a right to the use of water in said canal, ditch, flume, lateral, reservoir, dam, or lake, shall be entitled to be supplied from such canal, ditch, flume, lateral, dam, or lake, with water for irrigation of such land, and for mining, milling, and stock raising, in accordance with the terms of his or their contract; provided, that if the person, association, or corporation owning or controlling such water, and the person who owns or holds a possessory right or title to land adjoining or contiguous to any canal, ditch, flume, or lateral constructed and maintained under the provisions of this chapter, fail to agree upon a price for a permanent water right, or for the use or rental of the necessary water to irrigate the land of such person and for mining, milling, and stock raising, such person, firm, association, or corporation shall, nevertheless, if such person, association, or corporation has or controls any water not contracted to others, furnish the necessary water to such person to irrigate his lands, and for mining, milling, and stock raising, at such prices as may be reasonable and just; provided, further, that in case of shortage of water from drought, accident, or other cause, the water to be distributed shall be divided among all consumers pro rata according to the amount he or they may be entitled to, to the end that all shall suffer alike, and preference be given to none. The sale of the permanent water right shall be an easement to the land and pass with the title thereof, and the owner thereof shall be entitled to the use of the water upon the terms provided in his or their contract with such person or corporation, or in case no contract is entered into, then at just and reasonable prices. Any instrument of writing providing a permanent water right shall be admitted to record in the same manner as other instruments relating to the conveyance of land."

Article 3126 grants to the corporations and associations named in preceding article a right of way over public lands and grants right of condemnation of a right of way and land for reservoirs, etc., on and over the lands of private persons.

Article 3128 provides a mode of crossing roads and highways with canals. By article 3130 it is provided that the person, corporation, etc., who leases or rents the water to any person or corporation owning lands subject to irrigation "shall have a preference lien superior to every other lien upon the crop or crops raised upon the lands thus irrigated under such lease or control."

By article 3131 it is provided that a corporation organized for the purpose of irrigation shall have the right to acquire lands by donation or purchase, or in payment of stock or water rights, and to hold and dispose of such land or other property and to borrow money for the construction and maintenance of its canals, reservoirs, etc., and may issue bonds and mortgage its corporate and other property and franchises to secure the payment of any debts contracted for same; provided that all lands acquired by said corporation, except such as are used for the construction, maintenance, and operation of said canals, ditches, laterals, feeders, reservoirs, dams, lakes, and wells, shall be alienated within *fifteen years from the date of acquiring said lands, or be subject to judicial forfeiture.*

By article 641 (section 23) of the revised statutes, private corporations may be formed for the construction, maintenance, and operation of dams, reservoirs, lakes, wells, canals, flumes, laterals, and other necessary appurtenances for the purpose of irrigation, navigation, milling, mining, stock raising, and city waterworks.

There are other provisions of the statute law of Texas affecting irrigation, but they mainly concern details. The above are the more important statutes, and those under which the large irrigating corporations are organized and operating.

In April, 1905, the twenty-ninth legislature passed an act "to provide for the organization and government of irrigation districts, and to provide for the acquisition or construction thereby of works for the irrigation of the lands embraced within such districts, and to issue bonds in payment therefor, as authorized under the constitution, and also to provide for the distribution of water for irrigation purposes, and to furnish water for mechanical purposes; and granting to such irrigation district the right of eminent domain."

This gives in detail the method of organizing such districts under direction of the commissioner's court of the county in which such district, or the greater portion thereof, may lie. A petition signed by a majority of the holders of title in the proposed district is first presented to the commissioner's court, and if the court decides that the case comes within the provisions of the act an election is ordered within the boundaries of the proposed district. If two-thirds of the votes cast by legally qualified voters, who at the same time are resident property taxpayers in the district, are in the affirmative, the court enters an order to the effect that the district has been organized. At the same time that the above-named election is being held a board of directors, an assessor, tax collector, and treasurer are chosen also, and it is the duty of these officers to conduct the business affairs of the district. This act covers 25 printed pages, mostly relating to details of organization, sale of bonds, assessment and collection of taxes for the construction and maintenance of the district organization and irrigation system, etc., and is too extensive to be summarized here. Section 92 of the act provided that this statute shall not

repeal any existing statutes not inconsistent with this act, and that none of the provisions of it shall be construed as applying to water secured from wells.

In 1907 the thirtieth legislature passed an act authorizing the organization of drainage districts along lines somewhat similar to those of the 1905 irrigation act, at least as to organization and issuance of bonds, but providing a different method for the collection of taxes, and differing in some other details. This act was intended primarily for the relief of the coastal areas which for topographic reasons were deficient in natural drainage. It has application, however, to irrigated areas where there is danger of waterlogging the soil. At Barstow such a drainage district has been formed for the relief of lands irrigated by water from the Pecos River.

THE SETTLEMENT OF LANDS UNDER IRRIGATION SYSTEMS.

The State covers so large an area and the climatic, topographical, and other natural conditions are so varied, and the rainfall so variable and so differently distributed seasonally in portions of the State that it is impossible to give average values of the labor and expense necessary on the part of the settler to prepare the land for water and to establish a home which would even approximately apply to all sections, even for the same character of crops. It has been thought best, therefore, to insert the estimates of parties on the ground in each description of an existing or projected irrigation system, wherever such data could be obtained. While some of these are mere guesses, others are carefully made by competent irrigation men and the inquirer must judge of the value for himself. In most sections of the State labor is scarce and the daily wages quite variable. Along the Mexican border labor can be secured at small cost, generally about 50 to 62.5 cents per day without board. In the central and eastern portions of the State as much as $1.50 per day is frequently paid, though generally $1 per day or less would cover ordinary conditions. The higher price is generally paid during cotton-chopping season, when every day counts.

COST OF CLEARING AND PREPARING LAND FOR IRRIGATION.

The cost of preparing land for cultivation, either with or without irrigation, can not be given so as to represent a reasonable average for the whole State because of the wide variations in natural conditions. The cost per acre for clearing in timbered regions may be offset by the value of the timber in some localities, while in others this must be burned to remove it from the ground. With many mesquite roots to be grubbed out, the cost in some sections may be $10 or more per acre for this alone. No attempt is made here to estimate average costs of this character, and the inquirer is referred

to the answers given under the descriptions of existing and projected irrigation systems. The following cost of clearing and preparing land was the actual cost for a tract near Mercedes, and is a fair average of the cost of such work in the Rio Grande Valley:

Clearing land of timber:		
Contract price per acre of clearing timber and brush	$10.00	
Extras—		
Cutting timber into cord wood, 5 cords at 37.5 cents per cord	1.88	
Cutting timber into posts, 25 posts at 2 cents each	.50	
Cutting timber into railroad ties, 1 tie per acre, at 20 cents	.20	
		$12.58
Returns from sale of timber per acre:		
5 cords of wood	5.00	
25 posts	3.75	
1 railroad tie	.50	
		9.25
Actual cost of clearing timber		3.33

Cost of clearing land of roots.—In clearing the ground of roots a man and team can plow 2 acres per day. The following were the prices paid in this work per day:

Man	$0.625	
2-horse team and wagon	1.250	
Plowing, team and man	2.500	
Raking and hauling brush, 2 men and team	2.500	
Total	6.875	
First plowing:		
Plowing	$2.50	
Grubbing roots, 5 men	3.15	
Picking up roots, man and wagon	1.87	
Second plowing:		
Plowing	2.50	
Grubbing roots, 3 men	1.90	
Picking up roots, man and wagon	1.88	
Third plowing:		
Plowing	2.50	
Clearing roots, 2 men	1.25	
Picking up roots, man and team	1.87	
Total for 2 acres	19.42	
Total for 1 acre		9.71

Cost of preparing land for irrigation.

Man and team with Shuart grader or leveler, 2 days	$7.00	
Two men, 6 horses, and grader building levees, ½ day	2.00	
Building 1 mile of ditch	5.00	
Total		14.00
Clearing timber, roots, and preparing for irrigation		27.04

PRINCIPAL IRRIGATED CROPS.

RICE.

In growing rice under irrigation one man can handle approximately 100 acres up to harvest time. If he is just settling on a leased rice farm about $2,000 in money will be necessary to purchase teams, tools, seed, etc., to employ additional labor from time to time, and to maintain his family until the first crop is harvested. Many have made a success with less capital, while others have failed with more. Reliable men are often able to start with comparatively nothing by securing advances from merchants or landowners, but anyone not known in the community would find it difficult to secure these advances, even by offering to mortgage his stock or crops.

The following estimate of the cost of producing rice and the net returns was made by W. L. Rockwell, of the Office of Experiment Stations. This estimate is based on figures obtained from a number of successful growers and is a fair statement of the cost and returns under ordinary conditions. The average yield is 10 barrels per acre and can be increased. The net returns can be increased 25 per cent or more by intensive cultivation. The average price is $3.50 per barrel. The cost per acre of producing and marketing are itemized as follows:

Plowing	$1.50
Seed	1.25
Sowing	.75
Cultivation	4.50
Building levees	1.50
Irrigation	5.50
Harvesting	5.00
Marketing	2.00
Rent	5.25
Total	27.25
Average net returns per acre	7.75

BEANS.

The following figures as to the cost of raising beans in the lower Rio Grande irrigated area were furnished by W. A. McNeill, secretary-treasurer of the Santa Maria Irrigation Company:

Preparing land	$5.00
Seed, 1 bushel per acre	4.00
Planting	.50
Irrigating, four times, at $1 each	4.00
Harvesting, average of 200 bushels	20.00
Baskets, 200, at 16 cents each	32.00
Marketing—hauling, commission, etc	50.00
Total	115.50

The average yield is 200 bushels, and a conservative average selling price, $1.25 per bushel, gives a gross return of $250 and a net return of $134.50 per acre. Mr. Rockwell, however, states that at the time he was in the district—April or May, 1908—beans were selling at $3.50 per bushel. During May nonirrigated beans were being shipped out of Hempstead, Waller County, at about the same price.

ALFALFA.

One of the best paying crops grown under irrigation, and in some localities without it, is alfalfa. Under favorable climatic conditions, as in the Pecos Valley, it need not be replanted oftener than once in ten or twelve years. The number of cuttings vary from four to eight per season, the second cutting usually being heaviest. The average yield per cutting for a good stand is 1 ton per acre and the selling price varies from $8 to $16 per ton of baled hay, the average being ordinarily between $10 and $12. The cost of production, including baling and hauling to a shipping point, may be put at $20 to $30 per acre as an average. When grown under irrigation the crop does better if thoroughly disked after each irrigation. The same principle applies to nonirrigated alfalfa, the disking following the rains.

John Closner, of Hidalgo County, does not make an itemized estimate of costs or returns, but states that five to seven cuttings per season are obtained from alfalfa lands on the lower Rio Grande, and if these yield as much as 1 ton per cutting it is not difficult to figure large profits. The question of freight rates and the distance to the nearest market should be carefully considered. however, before going in for a crop of this or any other kind.

R. E. Smith, of Sherman, Grayson County, who it is estimated has 1,400 acres of alfalfa, and has been given the title of "alfalfa king," was asked for an estimate of the area planted to alfalfa in the State during 1908. He writes that he was unable to make such an estimate for lack of data. He raises alfalfa successfully without irrigation, but is fortunately situated as to the seasonal distribution of rainfall. Among other things he states in his letter: "I believe, however, that it will be found that there is not so much water needed for alfalfa after all when the meadows are properly cared for." He believes that by harrowing and proper cultivation of the meadows, and the maintenance of a good mulch on the ground the soil moisture can be conserved and irrigation dispensed with, though where the best results are to be attained water at the proper time is essential. He estimates that his extensive meadows will average 5 to 6 tons per annum, one of the cuttings—after the first and before the last—being reserved for seed. He states that this seed brings $9 to $10 per bushel and the yield will run 2 to 6 bushels per acre. Furthermore, the straw from this cutting will more than pay the expense of harvesting

and thrashing the seed. The selling price of alfalfa at the railroad station at Sherman varies from about $12 to $15 per ton. Mr. Smith sells his bright hay during the early part of the season, reserving the discolored hay for home use and for sale in winter when it is scarce, and he usually gets as much for the discolored as for the bright hay.

Mr. Smith states that by plowing Johnson-grass land during July and August a good seed bed for alfalfa is secured and most of the Johnson grass is killed, and if a good stand of alfalfa is secured the remaining Johnson grass will be effectively controlled. He believes, moreover, that about half-and-half alfalfa and Johnson grass make a better-balanced ration than alfalfa alone.

VEGETABLES AND TRUCK.

On the lower Rio Grande Valley, as in the rice district, the new settler will need $2,000 in cash or credit. The area one man can manage depends upon both the man and the crop grown. Truck requires much labor and often one man can tend but 5 acres, or even less. The average cost of producing and marketing cucumbers will run from $96 to $100 per acre. The average crop is about 200 bushels per acre, although 425 bushels have been raised. The average price is $1 per bushel and the average net return is approximately $100 per acre.

The following cost data for onions was furnished by E. C. Dustin, of Mamie, Tex., a station on the St. Louis, Brownsville and Mexico Railway, about 60 miles above Brownsville:

Cost of growing a crop of onions.

Rent of 1 acre of land	$12.00
Preparing 1 acre of land for planting	7.50
Cost of onion sets, from seed bed	2.00
Transplanting about 130,000 plants to the acre	15.00
Irrigating	6.00
Cultivating eight or nine times at 60 cents to 75 cents each	6.00
Topping	8.00
Plowing and picking	3.50
Sorting and crating	4.50
Crates, about 400 to the acre, at 18 cents each	72.00
Hauling to railroad (3 miles)	6.00
Freight and commission	28.00
Interest on $75 at 8 per cent	6.00
Total	176.50

The average yield was given as 400 bushels and the average price at $1 per bushel, leaving a net return of $223.50 per acre. During the season of 1908 onion growers in the vicinity of Laredo suffered severe losses because of the excessive use of water followed by a couple of heavy showers just after the last irrigation. These caused the onions to grow to unusual size, but on account of the excess of water con-

tained they would not stand shipment satisfactorily, and perhaps 25 per cent of the crop was lost. The consequences may prove ultimately to be beneficial, however, as the contemplated acreage for next season was so much in excess of that for 1908 that it would have been difficult at the present time to have procured a satisfactory market for the yield.

FUTURE DEVELOPMENT IN IRRIGATED FARMING.

Between San Antonio and the Rio Grande lie 25,000,000 acres of land, at least three-fourths of which will produce good crops. Through the Trinity, Brazos, Colorado, Guadalupe, and Rio Grande, 20,000,000 acre-feet of water annually flows to the Gulf, which is lost so far as Texas land is concerned. Besides this there are several small streams, as the San Antonio and Nueces rivers, which carry quite a volume during the early portion of the season. To this is to be added the artesian and shallow-well supply. In large sections of the northern and western parts of the State the same unused supply is available in a somewhat smaller amount.

It is impossible to even approximately forecast the future of irrigated farming in Texas, because of the great area of the State and the local variations in climatic and other natural conditions. Already there are upward of 400,000 acres and possibly as much as 500,000 acres under irrigation, and other systems of vast proportions are now in process of construction, besides numbers of small projects. On the lower Rio Grande development on a large scale is now most active, and it is estimated that when the systems now in process of construction are completed it will be possible to serve 180,000 to 200,000 acres or more in that vicinity alone. On the Southern Pacific Railway Company's "Rice Belt" map, David M. Duller estimates that 100 canal systems in Texas listed on that map are capable of covering ultimately nearly 1,200,000 acres, but this includes the Brownsville region and others not now devoted to rice culture. It does not, however, cover the irrigation from wells in the coastal region, nor the central or western districts. If one may judge by present development, it is possible that the area now irrigated may be more than doubled within the next ten years. Many times this area will doubtless be developed in the State eventually, provided the required amount of water can be conserved in the arid and semiarid portions, and even in the humid and semihumid districts the use of water will gradually be extended, not only for rice cultivation, but for the assistance it will render in fruit and truck growing, and even in the cultivation of staple crops. In such cases irrigation will serve as a species of insurance against periods of drought, even though the normal rainfall be sufficient ordinarily for the production of excellent crops. It is estimated that for the year

1907 the melon crop alone brought into the town of Hempstead, 50 miles northwest of Houston, on the line of the Houston and Texas Central Railroad, fully $100,000, and this without any irrigation and on poor sandy land formerly supposed to be worth very little for any purpose. Owing to heavy rains during the spring of 1908 the crop was delayed somewhat and the quality of the melons injured, but Waller County shipped during that year somewhere in the neighborhood of 800 carloads of melons, the number per car varying from 800 to 1,400. These have gone out of Hempstead principally. Because the crop was late and was thrown upon the market in a very short time prices slumped and it is probable that the net returns from shipments did not exceed $50,000 or $60,000. Waller County produces considerable quantities of radishes, beans, cantaloups, etc., as do many other counties of eastern and southern Texas, under natural conditions of rainfall; but with irrigation as an aid in dry seasons a good crop would be practically insured at a time when prices should be good, and even in ordinary seasons it would serve to prolong the season and possibly avoid glutting the market, with consequent depression in prices. In eastern Texas, as in other sections of the humid region, irrigation as an adjunct to natural rainfall should prove beneficial in the cultivation of fruit, vegetables, berries, etc., but it is not so used to any extent in that section, though near Beeville and other places it is practiced.

At a meeting of the Farmers' Congress, held during July, 1908, a resolution was adopted by the Rice Farmers' Association urging upon the legislature the creation of a state water board, or commission, with the particular idea of having this commission regulate land and water rents in the rice-growing districts. The moving cause of this resolution lay in a recent change in the system of land and water rentals by several of the larger canal systems, a fixed charge of $6 per acre for water having been substituted for the usual one-fifth of the crop produced, and a similar charge for land rent. A commission composed of competent men could do much, not only for the benefit of the rice growers but all classes of irrigators as well, and should be empowered to devise a system of equitable water distribution which would tend to conserve the water now available for existing systems and to fix penalties for the violation of promulgated rules. It might well investigate the question of rentals or tariffs on water and on land under irrigation, and also might establish standard rates and fix penalties for the abuse of water privileges, etc. There might, however, be a question as to the advisability of giving so much power to the commission.

At present there appears to be no adequate provision for the settlement of contentions regarding priority of claims to a given water supply, nor for the protection of riparian rights except by appeal to

the courts. The commission might well be empowered to investigate this subject and to recommend suitable legislation, even to the extent of drafting bills to cover the case, which would be submitted to the legislature from time to time for action as seemed desirable. It might be advisable to vest authority in such a commission to devise rules to cover certain phases of the question, and with the power to enforce these rules. There is need also of a state irrigation engineer, to act as advisor to the water commission or to be a member of that board. The collection of statistics and the issuance of circulars of instruction to irrigators should be a part of the duties of the office, and because of the vast area to be covered it might be desirable to establish subordinate or branch offices at several representative points in the State.

In addition to the reclamation of arid lands by irrigation, the problem of drainage in those regions where excessive rainfall or topographic conditions cause the lands to remain covered with water for long periods should be investigated. The need of action along these lines was recognized by the legislature when the present drainage act was passed in 1907. Active steps have been taken in the formation of drainage districts in some portions of the coast country, as at Angleton, Bay City, and perhaps at other points, where the work is practically ready to be gotten under way. At Barstow and Grand Falls, in Ward County, the people have organized drainage districts, for it is beginning to be recognized that even in the arid regions drainage is a valuable adjunct to irrigation, especially where excessive amounts of water have been applied to the land and water-logging of the soil has resulted. In portions of western Texas this excessive use of water has resulted also in bringing the alkali to the surface in such quantities as to injure seriously the productive qualities of the soil, and drainage would benefit such land materially.

While there is still an abundance of fertile arable land in sections where the normal rainfall is sufficient to mature certain crops, the high prices, which tend upward constantly, and the decreasing amount of undeveloped land of this character have a tendency to force development farther westward into regions of smaller rainfall, used heretofore chiefly for grazing purposes. In such regions of greater rainfall it is being demonstrated that many agricultural products not previously cultivated can be grown successfully and by the aid of irrigation can be made much more profitable than the old-time crops of corn and cotton.

The day of the large plantation and immense cattle ranch is passing and the number of small farmers is increasing rapidly. These are learning the economic value of growing a variety of products for home consumption. The rapidly increasing population will tend to accentuate the necessity for intensive as against extensive cultivation, all

of which will have the effect of bringing into prominence the importance of irrigation.

At present there is pressing need of systematic instruction in the economical use of water. On the rice lands which have a heavy clay bottom impervious to water, or nearly so, the methods of flooding by checks involves no serious loss by absorption, though there is a growing tendency among rice farmers to use less water than formerly, the check levees now being run so as to have a difference of level of not more than 3 or 4 inches on the average, as against 5 or more formerly. Moreover, the water is not now held so deep upon the upper side of the area inclosed by the levees as was formerly the case. In other types of land having an open, porous subsoil, flooding, especially by the border method almost universally used in the western portion of the State, leads to excessive dosing on the upper side of the area before the water can be made to reach the lower side. Mr. Rockwell states that the measured amount of water applied to one of these borders this season when the water had finally reached the most distant portion of the area was equal to a depth of 5.25 feet over the area. Such wasteful application leads not only to danger of water shortage on some portions of a given system, but also to water-logging of the soil and tends to cause the alkali to rise to the surface, destroying the fertility of the soil. A partial remedy for the wasteful use of water would be to change the rental method from a fixed amount per acre, now so common on systems where many farmers draw from the same canal, to a charge for the actual amount of water used, or for all used over and above a certain quantity per acre for which a flat rate has been fixed. If 1 acre-foot is sufficient for the production of a given crop on 1 acre, the use of from two to ten times that amount not only curtails the area which could be served but injures the land of the irrigator, or that of some one else on lower ground, and results in poorer crops. In some districts a different rental is now required for different crops, an indication of a partial recognition of the variation in the amounts of water required by different growths.

There is urgent need for systematic study of the duty of water for different varieties of crops and in different localities under different conditions as to temperature, rainfall, and evaporation. The "duty" of water is expressed in a variety of ways. Sometimes it is stated as the number of acres per season which will be served by a continuous flow of 1 cubic foot per second; sometimes as the number of acre-feet, or acre-inches, of water required to mature a given crop on 1 acre of land; another expression is found in the depths of water required per season per crop, but this is only another form of the second definition given above.

A single experienced irrigator in each locality could do more in the way of teaching others the proper methods to use in the application

of water to various crops by actual demonstration than could be accomplished by any amount of printed bulletins or even lectures. A good production with a smaller quantity of water than is being generally used would be the very best kind of instruction, for "seeing is believing" in cases of this kind. Steps should be taken to place men of this type on experimental farms in the typical irrigation districts of the State, and if these farms were devoted also to investigation of the best varieties of crops now grown, or the determination of such new ones as could be adapted to the local conditions, great economic value would thereby be given them.

O

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION—Continued.

BULLETINS—continued.

Bul. 157. Water Rights on Interstate Streams. By R. P. Teele and Elwood Mead. Pp. 118. (Separates only.)
*Bul. 158. Report on Irrigation and Drainage Investigations, 1904. Under the direction of Elwood Mead, Chief. Pp. 755. (Separates only.)
Bul. 167. Irrigation in the North Atlantic States. By Aug. J. Bowie, jr. Pp. 50.
Bul. 168. The State Engineer and His Relation to Irrigation. By R. P. Teele. Pp. 99.
Bul. 172. Irrigation in Montana. By Samuel Fortier, assisted by A. P. Stover and J. S. Baker. Pp. 100.
Bul. 177. Evaporation Losses in Irrigation and Water Requirements of Crops. By Samuel Fortier. Pp. 64.
Bul. 179. Small Reservoirs in Wyoming, Montana, and South Dakota. By F. C. Herrmann. Pp. 100.
Bul. 181. Mechanical Tests of Pumping Plants in California. By J. N. Le Conte. Pp. 72.
Bul. 183. Mechanical Tests of Pumps and Pumping Plants Used for Irrigation and Drainage in Louisiana in 1905 and 1906. By W. B. Gregory. Pp. 72.
Bul. 188. Irrigation in the Yakima Valley, Washington. By S. O. Jayne. Pp. 89.
Bul. 190. Irrigation in Northern Italy—Part II. By Elwood Mead. Pp. 86.
Bul. 191. Tests of Internal Combustion Engines on Alcohol Fuel. By C. E. Lucke and S. M. Woodward. Pp. 89.
Bul. 192. Irrigation and Drainage Laws of Italy. Translated by R. P. Teele. Pp. 100.
Bul. 201. Cost of Pumping from Wells for the Irrigation of Rice in Louisiana and Arkansas. By W. B. Gregory. Pp. 39.
Bul. 203. Distribution of Water in the Soil in Furrow Irrigation. By R. H. Loughridge. Pp. 63.
Bul. 205. Irrigation in Wyoming. By Clarence T. Johnston. Pp. 60.
Bul. 207. Irrigation in the Sacramento Valley, California. By Samuel Fortier, assisted by O. W. Bryant, J. E. Roadhouse, A. E. Wright, and J. H. Barber. Pp. 99.
Bul. 209. Irrigation in Oregon. By John H. Lewis, assisted by Percy A. Cupper. Pp. 67.
Bul. 210. Irrigation in South Dakota. By Samuel H. Lea. Pp. 60.
Bul. 211. Irrigation in Kansas. By Don H. Bark. Pp. 28.
Bul. 214. Irrigation in the State of Washington. By O. L. Waller. Pp. 64.
Bul. 215. Irrigation in New Mexico. By Vernon L. Sullivan. Pp. 42.
Bul. 216. Irrigation in Idaho. By J. Stephenson, jr. Pp. 59.
Bul. 217. Drainage of Irrigated Lands in the San Joaquin Valley, California. By S. Fortier and V. M. Cone. Pp. 58.
Bul. 219. Irrigation in North Dakota. By T. R. Atkinson. Pp. 39.

FARMERS' BULLETINS.

Bul. 116. Irrigation in Fruit Growing. By E. J. Wickson. Pp. 48.
Bul. 138. Irrigation in Field and Garden. By E. J. Wickson. Pp. 40.
Bul. 158. How to Build Small Irrigation Ditches. By C. T. Johnston and J. D. Stannard. Pp. 28.
*Bul. 263. Practical Information for Beginners in Irrigation. By Samuel Fortier. Pp. 40.
Bul. 277. Use of Alcohol and Gasoline in Farm Engines. By C. E. Lucke and S. M. Woodward. Pp. 40.
Bul. 371. Drainage of Irrigated Lands. By C. F. Brown. Pp. 52.
Bul. 373. Irrigation of Alfalfa. By Samuel Fortier. Pp. 48.

CIRCULARS

*Circ. 48. What the Department of Agriculture Is Doing for Irrigation. By Elwood Mead. Pp. 4.
Circ. 58. Irrigation in the Valley of Lost River, Idaho. By Albert Eugene Wright. Pp. 21.
*Circ. 59. Progress Report of Cooperative Irrigation Investigations in California. By S. Fortier. Pp. 23.
*Circ. 63. Work of the Office of Experiment Stations in Irrigation and Drainage. Pp. 31.
Circ. 65. Irrigation from Upper Snake River, Idaho. By H. G. Raschbacher. Pp. 16.
Circ. 67. Investigations of Irrigation Practice in Oregon. By A. P. Stover. Pp. 30.
Circ. 78. Progress Report on Irrigation Experiments in Willamette Valley, Oregon. By A. P. Stover. Pp. 25.

[Continued on fourth page of cover.]

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION—Continued.

SEPARATES.

*Rise and Future of Irrigation in the United States. By Elwood Mead, Expert in Charge of Irrigation Investigations, Office of Experiment Stations. Pp. 591–612. (Reprint from Yearbook, 1899.)

*Some Typical Reservoirs in the Rocky Mountain States. By Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 415–430. (Reprint from Yearbook, 1901.)

*Preparing Land for Irrigation. By R. P. Teele. Pp. 239–250. (Reprint from Yearbook, 1903.)

*Potato Culture near Greeley, Colo. By J. Max Clark. Pp. 311–322. (Reprint from Yearbook, 1904.)

The Relation of Irrigation to Dry Farming. By Elwood Mead, Chief of Irrigation and Drainage Investigations, Office of Experiment Stations. Pp. 423–438. (Reprint from Yearbook, 1905.)

The Use of Small Water Supplies for Irrigation. By Samuel Fortier, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 409–424. (Reprint from Yearbook, 1907.)

Soil Mulches for Checking Evaporation. By Samuel Fortier, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 465–472, figs. 7. (Reprint from Yearbook, 1908.)

*Duty of Water in the Gallatin Valley, Montana. By Samuel Fortier. Pp. II, 175–196, pls. 2, figs. 3. (Reprint from Bulletin 86 of Office of Experiment Stations.)

Irrigation in Utah. By R. C. Gemmell and Geo. L. Swendsen. Pp. iv, 197–218, pls. 12. (Reprint from Bulletin 86 of Office of Experiment Stations.)

*The Scope and Purposes of the Irrigation Investigations of the Office of Experiment Stations. By Elwood Mead, Irrigation Expert in Charge. Pp. 317–327. (Reprint from Annual Report of Office of Experiment Stations for 1901.)

*Review of Irrigation Investigations for 1902. By Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 359–385. (Reprint from Annual Report of Office of Experiment Stations for 1902.)

*Review of Irrigation Investigations for 1903. By Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 469–502. (Reprint from Annual Report of Office of Experiment Stations for 1903.)

Report of Irrigation and Drainage Investigations, 1904. By Elwood Mead, Chief. Pp. 425–472. (Reprint from Annual Report of Office of Experiment Stations for 1904.)

Losses of Irrigation Water and Their Prevention. By R. P. Teele. Pp. 369–386. (Reprint from Annual Report of Office of Experiment Stations for 1907.)

Review of Ten Years of Irrigation Investigations. By R. P. Teele. Pp. II, 355–405. (Reprint from Annual Report of Office of Experiment Stations for 1908.)

1229 Issued February 4, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN 223.

A. C. TRUE, Director.

DIETARY STUDIES IN PUBLIC INSTITUTIONS IN PHILADELPHIA, PA.,

BY

MISS EMMA SMEDLEY AND R. D. MILNER,

AND

DIETARY STUDIES IN PUBLIC INSTITUTIONS IN BALTIMORE, MD.,

BY

H. L. KNIGHT, H. A. PRATT, AND C. F. LANGWORTHY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, D. Sc., Director.

E. W. ALLEN, Ph. D., Assistant Director and Editor of Experiment Station Record.

C. F. LANGWORTHY, Ph. D., Expert in Nutrition.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., October 15, 1909.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 223 of this Office, a report on the results of 8 dietary studies in homes for the aged and 3 in orphan asylums in Philadelphia and Baltimore, carried on by R. D. Milner, Miss Emma Smedley, H. L. Knight, H. A. Pratt, and C. F. Langworthy.

The institutions were of two types, namely, those supported by public funds and those supported largely by private endowment.

One object of the investigation was to secure data regarding the food consumption of aged men and women and children for use in formulating dietary standards for such individuals, in comparison with an adult man in full vigor. It is often a matter of great importance, particularly in the expenditure of public funds, to determine whether the diet of an institution corresponds in all respects to reasonable standards, and one of the principal objects of the investigation here reported was to test the value for making such comparisons of methods elaborated in cooperation with the nutrition investigations of this Office. The results indicate that the object sought can be attained, and demonstrate that with the data now available it is possible for the nutrition expert to pass upon the dietary problems of an institution in the same way that a public accountant can pass upon the financial affairs of a commercial enterprise, and it seems fair to say that the data obtained are as useful in the one case as in the other.

Acknowledgment should be made to the managers of the several institutions studied and to the matrons and other officials for making the work possible and aiding it in many ways.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

DIETARY STUDIES IN PUBLIC INSTITUTIONS.

DIETARY STUDIES IN PHILADELPHIA.

By Miss Emma Smedley and R. D. Milner.

INTRODUCTION.

As a part of the nutrition investigations of the Office of Experiment Stations, dietary studies were made in a home for aged women and in an orphan asylum in Philadelphia, the results of which are here reported. The work was carried on in cooperation with Drexel Institute and was undertaken primarily to secure data regarding the food consumption of aged persons and children and also as a demonstration of the importance of such studies as a means of judging of the effectiveness of the system of institution management followed and the nutritive value and character of the diet in comparison with dietary standards.

DIETARY STUDY IN OLD LADIES' HOME.

The home for aged women in which this study was made is under the care of a benevolent association. In January, 1907, the home celebrated its ninetieth anniversary. During its many years of usefulness it has had as its managers many able women, and not a few of the present managers are granddaughters or great-granddaughters of the organizers of the society.

The building now occupied was erected in 1887. It is large, commodious, and surrounded by a spacious yard, in which are many trees and a flower garden. It is so arranged that all the rooms occupied by the old ladies are sunny a part of the day. On each floor there are sitting rooms for the inmates, and a library has been provided for them. One section of the second floor is used for an infirmary, where the feeble and sick may be made more comfortable under the care of a trained nurse and her assistants.

There were 113 old ladies in the asylum at the time the dietary study was made, 10 of whom were between the ages of 65 and 70, 73 between 70 and 80 years, 20 between 80 and 90 years, and 10 between 90 and 100 years.

The employees consisted of a matron and 1 assistant; a trained nurse and 5 assistants; 12 women, including cooks, laundresses, and housemaids; and 3 men, an engineer and his assistant and a "chore" man. One man was away at the time of the dietary study.

The general health and happiness of the whole family was remarkably good. The old ladies assist in preparing the vegetables for the table, and sew or perform other light duties about the house in so far as they are able.

STAPLE FOODS AND METHODS OF SERVING.

The matron buys all food, selected according to the market supply, under the direction of the managers. She also arranges the menus and gives her personal oversight to the preparation and serving of the meals. There is more variety in the diet than is usually found in an institution; it is like a home table, and the food is well prepared, attractive, and appetizing.

All food is prepared in the basement kitchen and carried by dumbwaiter to the main dining room on the first floor and to the infirmary on the second floor. The same food is served to all of the employees. Extra dishes, as beef tea, mutton broth, albumen water, and gruels are prepared in the infirmary for those requiring special diet.

The bread is supplied by a baker who makes it in 2-pound loaves, 8 loaves to a pan, thus avoiding a large amount of crust which would probably be wasted.

Coffee, tea, and milk are always served for breakfast, tea or coffee and milk for dinner, and tea and milk for supper.

An examination of the menus showed that rice is served nearly every day as well as potatoes and a green vegetable, the rice sometimes taking the place of dessert, when it is eaten with sugar and milk.

Meat left from dinner is usually served to the few who wish it for supper. Roast beef is always served cold for dinner on Sunday. Cake of some kind is served Sunday night in place of the hot dish which is used on week days.

Food is allowed in unlimited quantities, and the fact that there is remarkably little waste from the table proves that it is appetizing.

The following is a representative sample of the menus used during the week of the study:

Menu for Tuesday, May 14.

Breakfast: Oatmeal, dry flaked cereal, chipped beef, potatoes, bread and butter, tea, coffee, milk, sugar.

Dinner: Fried ham, mashed potatoes, lettuce and dressing, boiled rice, coffee, bread and butter.

Supper: Corn muffins, butter, tomato preserves, tea, milk.

METHOD OF MAKING THE DIETARY STUDY.

As all food is prepared in one kitchen, it was necessary to record only the weights of food materials on hand at the beginning of the study, as bread, butter, milk, sugar, and meat; all supplies purchased or taken from the storeroom during the week, and, at the end of the week, the weights of materials on hand. Meat was weighed as purchased and vegetables as prepared for cooking. Many loaves of bread were weighed and the average weight used in the calculations. The same method was employed for cereal breakfast foods which were purchased in boxes.

The weight of table waste was also recorded each day.

From these figures are calculated the nutritive value of the food served and wasted per person per day.

It was not thought necessary to analyze any food materials, the composition being assumed from a previous publication.[a] The figures in parentheses following the names of food materials in the table on page 10 refer to manuscript tables on file in this Office showing the data thus used.

The fuel value of the foods used was calculated by the use of factors given in Principles of Nutrition and Nutritive Value of Foods.[b]

It was assumed that the composition of the total waste was the same as the average composition of the total food supplied.

DETAILS OF THE DIETARY STUDY.

This study covered a period of seven days, beginning May 14, 1907, during which time 2,811 meals were served, 2,365 to the old ladies, 406 to the women employees and occasional visitors, and 40 to the men employees.

Several old ladies and a number of the employees were away one or more meals during the week.

The total food materials used, with their cost and nutrients, are given in the table on page 10, at the end of which are also given the cost and nutrients supplied per woman per day.

To determine the amount of food eaten by the employees, it was assumed that each man consumed 125 grams of protein, 125 grams of fat, and 400 grams of carbohydrates per day, and each woman 0.8 of this amount. The amounts of nutrients thus estimated were subtracted from those of the total food to give the amounts actually eaten by the inmates, and from these last the amounts per woman per day were calculated. It was impossible to distinguish between employees and inmates in considering the daily cost, which is, therefore, calculated per person per day.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 28 revised, and Farmers' Bul. 249.

[b] U. S. Dept. Agr., Farmers' Bul. 142.

Weight, cost, nutrients, and fuel value of total food and that consumed per woman per day, dietary study No. 691.

Kinds, amounts, and cost of material.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.					
	Dollars.	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Beef, veal, and mutton: Beef, chipped, dried, 12.8 pounds, $2.30 (1); ribs, 112 pounds, $17.92 (3); rump steak, 37.5 pounds, $6.66 (2); veal, liver, 11 pounds, $2 (6); lamb, chops, 10 pounds, $1.80 (4); shoulder, 39.5 pounds, $6.22 (5)	36.90	15,754	18,653	....	229,026
Pork, etc.: Bacon, 17 pounds, $2.89 (7); ham, with bone, 23.8 pounds, $3.80 (8); salt pork, 6 pounds, $0.90 (9); lard, 2.5 pounds, $0.29 (10)	7.88	2,496	10,902	....	107,014
Fish, etc.: Mackerel, 19 pounds, $2.85 (12); shad, 64 pounds, $10 (11); oysters, canned, 3 pounds, $0.10 (62)	12.95	6,775	4,617	53	68,410
Eggs, 76 pounds, $9.50 (14)	9.50	4,102	3,206	....	44,944
Dairy products: Butter, 71.5 pounds, $27.17 (15); buttermilk, 30 pounds, $0.36 (16); cheese, 4 pounds, $0.62 (18); milk, 922 pounds, $25.36 (17)	53.51	15,056	45,015	21,570	547,137
Total animal food	120.74	44,183	82,393	21,623	996,534
VEGETABLE FOOD.					
Cereals: Barley, pearled, 1.3 pounds, $0.05 (20); corn meal, 21 pounds, $0.42 (26); oatmeal, 21 pounds, $0.63 (19); rice, 13.5 pounds, $0.95 (24); wheat flour, 61.3 pounds, $1.54 (25); farina, 5 pounds, $0.35 (22); breakfast food, 9 pounds, $1.10 (32); bread, white, 146 pounds, $5.48 (27); bread, graham, 48.5 pounds, $1.70 (28); breakfast rolls, 18 pounds, $0.96 (29); cake, Dutch, 21 pounds, $1.12 (30); cookies, sugar, 5.5 pounds, $0.55 (31); macaroni, 3.5 pounds, $0.28 (33)	15.13	15,891	3,773	102,863	508,399
Sugars and starches: Molasses, 2 pounds, $0.12 (35); sugar, granulated, 185.5 pounds, $9.27 (34); cornstarch, 2.8 pounds, $0.21 (36)	9.60	22	....	85,894	343,663
Vegetables: Beans, pea, dried, 10 pounds, $0.45 (37); beans, Lima, 7.8 pounds, $0.47 (38); cabbage, 39.5 pounds, $1.30 (39); lettuce, 32.5 pounds, $1.70 (41); onions, 2.5 pounds, $1 (43); potatoes, 188.5 pounds, $3 (45); potatoes, 44 pounds, $1 (46); radishes, 3.8 pounds, $1 (47); spinach, 52 pounds, $2.60 (48); tomatoes, 1 pound, $0.10 (50)	12.62	4,900	416	26,101	127,702
Fruits: Bananas, 78 pounds, $2.88 (54); rhubarb, 24.5 pounds, $1.50 (58); strawberries, 70 pounds, $7.85 (60); plums, canned, 25 pounds, $1 (57); prunes, 10 pounds, $0.75 (56); tomatoes, preserved, 20.5 pounds, $0.50 (58)	14.48	871	430	18,516	81,375
Olive oil, 1 pound, $0.75 (61)	.75	....	454	....	4,041
Total vegetable food	52.58	21,684	5,073	233,374	1,065,380
Total food	173.32	65,867	87,466	254,997	2,061,914
Waste	....	5,070	6,854	19,906	160,910
Total food consumed	....	60,797	80,612	235,091	1,900,995
Food of employees	....	15,313	15,313	55,007	417,561
Food consumed by inmates	....	45,484	65,300	180,083	1,483,434
Food consumed per woman per day	[a] 18	58	83	228	1,882

[a] Per person per day; see page 9.

DISCUSSION OF RESULTS.

According to the table each inmate of the home received during the time of the study 58 grams of protein and 1,882 calories of energy a day, at a cost of 18 cents. The amounts of nutrients thus supplied are noticeably lower than those in the Baltimore studies reported elsewhere in this bulletin, or than almost any others on record in the investigations of this Office for persons of similar requirements. Since there was no limit to the amount of food served it is evident that the

subjects satisfied their hunger, and the comparatively small table waste seems a proof that they found the food appetizing. The question of the adequacy of the diet to their needs is discussed in another section of this bulletin (see p. 40).

The cost, 18 cents per person per day, is not excessive, considering the variety of foods served. If the strictest economy were necessary, materials could undoubtedly be selected which would furnish as large quantities of nutrients for a smaller sum or larger quantities for the same sum, but probably not with as appetizing a variety, especially in the matter of fruit and vegetables. Such pleasing variety in the diet actually adds to its nutritive value by stimulating the flow of digestive juices, a consideration of especial importance in the case of persons in whom, as in the subjects of this study, the vital processes tend naturally to become sluggish.

In general, it may be said that the diet was in reasonable accord with commonly accepted standards and that the dietary problems were handled in accordance with the requirements of good management. The food was adequate, well prepared and served, and the cost reasonable as compared with the resources.

DIETARY STUDY IN AN ORPHAN ASYLUM.

The orphanage where the dietary study was made is located in a suburb about 13 miles from Philadelphia. It is under management similar to the home for old ladies in which dietary study No. 691 was carried on. At its foundation in 1814 it was the only institution of the kind in Philadelphia, and it has always occupied a high place among public institutions of the city. In 1906 it moved into its present quarters, where it has the advantages of country surroundings.

The buildings, admirable in their external construction and an ornament to the neighborhood, have proved thoroughly adapted to the purposes of the asylum. Well lighted and well ventilated, and provided with every convenience, they furnish to the children the same provisions for comfort and health which would be expected in a private house. The surrounding grounds afford opportunity for exercise in the open air and for instruction in farming and gardening.

The children have a very free and happy life, and were all in excellent health. All who are over 6 years old attend school each day in a school maintained in the asylum, where, beside their regular studies, the boys receive instruction in carpentry and the girls in sewing, housework, and stenography. Besides going to school each child has some regular household duty to perform, under the supervision and instruction of a care taker. The girls do all the work in their dormitories and halls, help in the kitchen, dining rooms, and laundry, wash all the dishes, and have care of the pantries. The older girls do their own sewing and also help with the mending for

the smaller girls. The boys take care of their dormitories and halls, carry coal for the cook, and assist the man in the care of the lawn and garden. The boys are also taught to sew and the older ones mend the stockings for the younger ones. Each older boy and each girl is made responsible for the conduct of a younger child. The family feeling is especially encouraged, and the matron endeavors to give the children a mother's care and sympathy.

There were 80 children in the home at the time the study was made, their ages ranging as follows:

Number and age of children in orphan asylum.

Girls.	No.	Boys.	No.
Between 15 and 18 years	8	Between 13 and 14 years	6
Between 13 and 14 years	10	Between 12 and 13 years	5
Between 10 and 12 years	8	Between 10 and 11 years	4
Between 6 and 9 years	11	Between 6 and 9 years	14
Under 6 years	7	Under 6 years	7
Total girls	44	Total boys	36

The average age of the girls was a little less than 11 years; that of the boys a little less than 9 years.

The officers of the home, 11 in all, at the time the study was made, included a matron and assistant, 2 teachers, nurse, seamstress, and 5 care takers. A cook, 3 laundresses, and 1 man were also employed.

The matron buys most of the table supplies in Philadelphia. Milk, which furnishes the largest item in the menu, is supplied from a well-equipped dairy in the neighborhood. Green vegetables and eggs are also purchased from a neighboring farm.

The meals are served at regular hours each day, and half an hour is allowed for each meal, the children being allowed all they will eat in that time. The matron and caretakers are always in the dining room while the children are eating, to help the little ones and to encourage all to be neat, careful, and thoughtful.

The diet of the children is very simple, as will be gathered from the menu for a representative day. They are not allowed to have food between meals, except occasionally as a treat.

The officers' meals are served in another room after the children are through, and their food is different from that served to the children. The other employees are also given a diet slightly different from that of the children. The menu for the children for a representative day during the time of the study, May 18 to May 24, 1907, was as follows:

MENU FOR SATURDAY, MAY 18.

Breakfast: Oatmeal, milk, sugar, bread, butter.

Dinner: Frizzled beef, hard-boiled eggs, bread, butter, milk.

Supper: Stewed peaches, bread, butter, milk; pudding to a few older girls.

METHOD AND RESULTS OF THE DIETARY STUDY.

In order to avoid the confusion which might otherwise arise between the food served to the children and that served to the officers and employees, all the materials served to the children were measured just before serving. The table waste from each kind of food was also separately measured and subtracted from the amount served. The results of the study as given in the table below therefore represent the amounts actually eaten by the children.

The composition of the food materials was assumed from data in earlier publications.[a] The significance of the figures in parentheses in the table was explained on page 9.

It was not feasible to include the cost of food in the observations made during this study, as so much of the food, i. e., milk and garden produce, was of home production.

The study covered a period of seven days, beginning May 18, 1907. There were 80 children at the orphanage for the first four days, when one girl became of age and left the home. All calculations are therefore made for 79.5 children for one week, or one child for 556.5 days.

The detailed results of the study are given in the following table:

Weight of total food and nutrients and fuel value per child per day, dietary study No. 692.

Kinds and total amounts of food materials.	Per child per day.			
	Protein.	Fat.	Carbohydrates.	Fuel value.
ANIMAL FOOD.				
	Grams.	*Grams.*	*Grams.*	*Calories.*
Beef: Dried, chipped, 5 pounds (1); rump, steak, and stew, 41 pounds (2); ribs, 16.5 pounds (3)	8.1	9.8		120
Lamb: Shoulder, 16 pounds (5)	1.8	2.0		25
Pork: Salt, 5.5 pounds (9)	.3	2.5		23
Fish: Cod, fresh, 18 pounds (13)	1.1			4
Eggs: 5.75 pounds (14)	.6	.4		6
Dairy products: Butter, 14.75 pounds (15); milk, 823.75 pounds (17)	22.3	37.1	33.6	554
Total animal food	34.2	51.8	33.6	732
VEGETABLE FOOD.				
Cereals: Oatmeal, 16.75 pounds (19); cream of wheat, 18.25 pounds (23); corn flakes, 4 pounds (21); rice, 2 pounds (24); wheat flour, 5 pounds (25); white bread, 272.75 pounds (27); cookies, 11 pounds (31); rice pudding, 4 pounds (63)	26.2	5.3	152.9	764
Sugars and starches: Cornstarch, 0.75 pound (36); molasses, 0.5 pound (35); sugar, 52 pounds (34)			43.2	173
Vegetables: Beans, pea, dried, 12.5 pounds (37); corn, canned, 20.5 pounds (40); cucumbers, 20 pounds (42); onions, 2.5 pounds (43); peas, canned, 41.5 pounds (44); potatoes, 137 pounds (45); string beans, canned, 6.75 pounds (49); tomatoes, canned, 21 pounds (51)	6.9	.6	34.7	172
Fruits: Strawberries, fresh, 18 pounds (60); apples, dried, 7.5 pounds (53); peaches, dried, 6.75 pounds (55)	.3	.2	5.7	26
Total vegetable food	33.4	6.1	236.5	1,135
Total food	67.6	57.9	270.1	1,867

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 28, revised, and Farmers' Bul. 249.

DISCUSSION OF RESULTS.

It is ordinarily assumed that children the ages of those in this study or a trifle older require 0.6 of the amount required by a man at moderately active work. This would mean about 63 grams of protein and 2,100 calories of energy. The present study falls a little below this in energy, but shows 5 grams more protein. The general question of the food requirements of children and the adequacy of the diet in this and similar studies is discussed in a later section of the bulletin (see p. 87).

As regards the variety of materials used, the list presented in the table (p. 13) speaks well for the judgment of the purveyor. There is a greater variety of meats than in many such institutional dietaries, and also of vegetables and fruits. No data are available regarding the cost, but it is known not to have been beyond the means of the establishment, and undoubtedly provided a pleasing diet for the children.

As was the case in the Philadelphia home for aged women, the diet was adequate, whether judged by the nutrients and energy it supplied in comparison with commonly accepted dietary standards or by the physical condition of the children. The food was simple—as should be the case, particularly with children—and was wholesome and reasonable in cost, and was prepared and served with care and due regard to good standards.

DIETARY STUDIES IN BALTIMORE.

By H. L. Knight, H. A. Pratt, and C. F. Langworthy.

INTRODUCTION.

The following report comprises the results of a group of dietary studies made in charitable institutions for the aged and for the orphaned in Baltimore, Md. One object was the same as that of previous studies made in public institutions as a part of the nutrition investigations of the Office of Experiment Stations, namely, to secure accurate data regarding dietary conditions in comparison with the commonly accepted standards, in order that the management might know how satisfactory was the system followed and whether the food was adequate and met other reasonable requirements. There was, moreover, the further purpose of obtaining more information regarding the food consumption of elderly persons and children. Some investigations have been made in Europe regarding the nutritive demands of the aged, and from the data thus obtained it has been assumed that persons in the decline of life require 0.8 of the food of younger adults in corresponding circumstances, but this factor needs further verification. Even less investigation has been made regarding the food requirements of children beyond the age of infancy. It is evident that additional information on these points will be of immediate value to both the practical dietitian and the physiologist.

The institutions in which the present studies were carried on are believed to be typical of their respective kinds, namely, charitable institutions where rigid economy is absolutely essential, and institutions which are not of this character, but are rather to be considered as homes for aged persons and for orphan children, in which they may have the care and the comforts which are possible with more abundant resources. Bayview, the Baltimore city almshouse, in which the first series was made, is perhaps typical of public institutions where economy is essential. The next three studies were conducted in a home for aged women, a home for aged men, and the German Aged People's Home (Allgemeine Deutsche Greisenheimat), institutions under private management. The remaining two studies were made in children's homes, the Maryland Home for Friendless Colored Children, and the German Orphan Asylum (Allgemeines Deutsches Waisenhaus). In all cases the studies were carried on with the full consent of the managers and the helpful cooperation of the officials of the homes.

COMPOSITION OF FOOD MATERIALS AND WASTE.

The foods used in these studies were for the most part so simple and similar to those in common use in this country that it was deemed

unnecessary to analyze them. The composition of almost all was, therefore, assumed from previous analyses of similar materials given in earlier publications of this Office. Composite samples of the waste from each of the last five studies and of samples of certain ingredients of the waste in the Bayview studies were, however, especially analyzed, as were also a few food materials. Only the percentage of protein was found in these analyses, which was obtained by multiplying the percentage of nitrogen by the factor 6.25. The heats of combustion were determined by the use of a bomb calorimeter, and from that the fuel value or energy was computed by means of the factors of availability commonly used in dietary studies.[a]

The table below gives the analyses specially made. In the detailed results of dietary studies which follow a reference number is given in parentheses after each material. These numbers refer either to this table or to manuscript tables kept on file in this Office, in which are shown the previous analyses which are assumed to represent the chemical composition of these materials.

Protein, heat of combustion, and fuel value of materials analyzed, dietary studies Nos. 682–690.

Reference number.	Food materials.	Protein (N×6.25).	Heat of combustion per gram.	Fuel value per pound.[b]
	ANIMAL FOOD.			
		Per cent.	*Calories.*	*Calories.*
1	Beef, "sides and rattlers," cooked, edible portion	28.8	3.059	1.207
	VEGETABLE FOODS.			
	Cereals:			
2	Oatmeal, boiled	1.1	.370	.153
3	Rice, boiled	1.0	.553	.228
4	Bread, rye	10.6	3.018	1.246
5	Bread, wheat	9.8	2.481	1.024
6	Cake	8.1	4.316	1.782
7	Vegetables: Cabbage sprouts, boiled	4.0	.997	.412
	Fruits:			
8	Apple butter	c.5	c.112	.444
9	Apple sauce (evaporated apples)	.3	.990	.395
10	Do	c.3	c.561	.224
	MISCELLANEOUS FOODS.			
	Soup:			
11	Chicken	8.0	1.078	.421
12	Vegetable	2.5	.865	.337
13	Mutton, with vegetables	6.0	.713	.278
14	Beef, with vegetables	1.4	.550	.215
15	Do	6.9	1.188	.463
16	Do	4.1	.844	.325
17	Average, Nos. 12, 11, 15, and 16	d4.9	d.859	.335
18	Gravy, for meat	1.9	.795	.310
	WASTE.			
19	Broth, waste from soup, studies Nos. 682–685	.8	.128	.50
20	Composite sample, study No. 686	5.3	1.432	.598
21	Composite sample, study No. 687	4.7	1.350	.563
22	Table waste, composite sample, study No. 688	1.7	.496	.207
23	Kitchen waste, composite sample, study No. 688	4.3	1.104	.461
24	Composite sample, study No. 689	5.2	1.645	.687
25	Composite sample, study No. 690	3.6	1.140	.476

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 152, p. 13. For waste 92 per cent was taken, the figure there given for combination meals; for apple butter, 98 per cent, the figure for sugar.
[b] Calculated from heat of combustion per gram.
[c] Protein assumed from previous analysis; heat of combustion determined.
[d] Estimated.

DIETARY STUDIES AT BAYVIEW ASYLUM.

The data for this series of studies were collected by Mr. H. A. Pratt, at Bayview Asylum, Baltimore, Md., in May, 1905, the investigation being carried on with the cooperation of the board of charities, to find the existing food consumption, the character of the food supply, and the methods of cooking and serving food, with a view to making suggestions for improvements if necessary and possible, and to obtain data regarding the food consumption and requirements of elderly men and women, the population of Bayview being largely composed of such persons. This institution, which is pleasantly located in the eastern suburbs of Baltimore, overlooking Patapsco Bay, is the almshouse of Baltimore, and is under the direction of the city board of charities. To it are admitted those of the city poor who are unable to support themselves and have no one on whom they can depend, and also poor people who are unfit to care for themselves by reason of physical or mental disability. While not primarily an insane asylum, Bayview, at the time of the study, admitted the pauper insane of the city and cared for them in a separate ward. The State has since taken over such patients. The report of the city board of charities for 1904 says:

> There has been a difficulty in securing a recognition of the proper function of Bayview as an infirmary and hospital. It is neither a reformatory nor a penal institution. It is intended for persons who are sick, infirm, or aged, who are unable to support themselves or to find others to support them. It is not intended for the able-bodied or for persons in need of reformation.

The average population of Bayview in 1904 was about 1,348, of whom 625 were insane and hospital patients, and the majority of the remainder (723) aged men and women. The population is, however, very variable, being larger in winter than in summer, since there are always, as in all cities, a certain number who seek public shelter during the cold winter. It is also true that a considerable number of the inmates work on farms during the summer and return after the farming season. At the time of the study the inmates were very largely persons ranging from middle life to old age, the number of men and women being about equal, and there were many infirm and maimed or crippled persons among the number. The large number of hospital patients consisted not only of the persons who became ill while inmates of the institution, but also of pauper patients transferred from the city hospitals.

The inmates did nearly all the work of the institution, both indoors and on the institution farm. This is over 200 acres in extent and yields a large part of the vegetables consumed by the inmates and employees. A number of those who did regular work received wages for their services. No work was carried on at Bayview except that

incident to the operation of the institution—that is, nothing was manufactured for sale.

The institution life of the inmates was very regular. They rose early in the morning, the rising bell ringing at about 5.30 a. m. They also retired early, the great majority being in bed before 9 o'clock, the official time for "lights out." The meals were served at regular hours, although the hours in each division of the institution were not precisely the same, and the women ate breakfast somewhat later than the men. On Sundays supper was served earlier than on the other days of the week. Religious services were conducted daily by different church organizations, and occasional entertainments were provided by various charitable organizations in the city for the amusement of the patients.

All matters pertaining to the management of Bayview have received very careful attention from supervisors of city charities and from the institution officials. Several years before the studies were made the dietary question was carefully considered by one of the members of the board who had had a great deal of experience in the study of nutrition problems. As a result the rations now supplied were determined upon because they were believed to meet the requirements of the subjects and to conform to the commonly accepted dietary standards, while at the same time they were reasonably varied and palatable and came within the sum available for food expenditures per person per day. The dietary as thus arranged has proved fairly satisfactory, as was shown by the fact that the inmates retained their accustomed health and strength to a noticeable degree, considering the large proportion of aged and infirm.

The buildings of the institution were well adapted to their several purposes, though at the time of the studies somewhat overcrowded. They were particularly noticeable for the neatness and cleanliness everywhere evident. The main building, which was the one in which the dietary studies were made, was of brick, four stories high, one wing being used for male and the other for female inmates. Each section had its hospital and its sun parlors in addition to dormitories, dining room, lavatories, etc. The official force had their living rooms and dining rooms in the center of the main building, and there were also one or two large public rooms.

A part of the food supplied to the divisions studied was cooked in the "diet kitchen," but the greater portion in the so-called "county kitchen." The "diet kitchen" was situated in a wing in the rear of the building and was especially equipped for its purpose. From it was served a part of the menu for the regular inmates and also for the hospital patients of the institution. The "county kitchen," in the basement of the main building, was the principal kitchen of the institution, and most of the food for the inmates was cooked there.

It was of good size, clean, and orderly, and seemed to answer its purpose very well. All the workers in this kitchen, including the head cook, were inmates. The bakery of the institution, where all the bread used is baked, was also well equipped. It was situated in the basement of the main building, directly back of the " county kitchen."

STAPLE FOODS AND METHODS OF SERVING.

Some observations in regard to the staple foods of the institution and the way they are served are of interest, preliminary to a consideration of the dietary studies.

In general, it should be said that the officers of the institution made a special effort to see that all the provisions purchased were of the very best quality that could be secured with the funds at their disposal.

All foods which were purchased were bought under contract if the amount exceeded 500 pounds. The number of cooked articles served to the inmates was comparatively small, bread, coffee, and soup being the three staple articles of diet. For two or three weeks in the spring and during the time of these studies, fish and coffee were served in place of the soup on Fridays. Otherwise, the soup, which should more properly be called a stew, was cooked and served every day of the week except Sunday. As a rule this soup was made of beef and vegetables, though mutton was used in place of beef one day in each week, either Friday or Saturday. Two methods of making the soup were followed. On Mondays and Thursdays the meat was boiled, cut from the bones, and after being apportioned in lots suitable for the different dining rooms, was placed in kettles, where it was kept hot until served, becoming in the meantime more or less brown and savory, so that it resembled a pot roast. A gravy was provided for the meat in some but not in all of the dining rooms. Into the stock from the boiled meat were put the vegetables which always made up a part of the dinner—potatoes, carrots, onions, etc. These were then boiled and the soup, or broth, i. e., stock plus vegetables, was apportioned to the several dining rooms. The meat was served on plates, a ration to a person, while the broth was served in tin cups. This entire dinner was called " soup " at the institution, and is so called throughout this report, though the meat was served entirely separate from the broth.

On other days the soup was made in the usual way, that is, the meat was cooked, then boned, and replaced in the kettle with the potatoes and other vegetables. To prevent its breaking up too much the cooked meat was not added until the vegetables were partly done. A small quantity of flour was added to the soup to thicken it slightly, and salt and pepper were of course used. This soup was very palatable, resembling stew rather than soup, and seemed on the whole to be

well liked. In this case the meat and broth were served together. In general, the thicker the soup, that is, the more meat and vegetables it had in it, the better it was relished.

The beef which the institution used was mostly the portions known as "sides and rattlers," the better cuts of the former being reserved for the officers and employees. It was purchased from Baltimore dealers. While economy demanded that the meat be cheap, it appeared to be of good quality. It was always subjected to a careful inspection by the steward before being received. Fresh roast pork, raised at the asylum, was served on Sundays during the winter season in place of the smoked pork shoulder.

The use of fish was rather restricted at Bayview. During part of the year the women inmates who worked received salt herring for breakfast one morning each week. In general, fresh fish was not supplied, but in the spring, when fresh herring were in season, they were served baked for the Friday dinner, and formed a palatable dish. When this change was made in the menu mutton soup was served on Saturday instead of Friday, as at other seasons.

The bread baked at the institution was excellent in quality, an experienced baker being in charge of this department. The bread served to the inmates was made of a mixed spring and winter wheat flour. This yielded a loaf which, though not absolutely white in color, was light, tender, and of excellent flavor, with a crust nicely browned but not too thick. The bread was practically uniform in quality. These characteristics, always desirable, are essential when, as at Bayview and many other institutions, bread forms the basis of the diet.

During the green-vegetable season two kinds were served on Sundays. Throughout the summer corn, peas, etc., were added to the soup when they could be obtained from the farm. Radishes and onion tops were served to the various dining rooms in season, generally for supper, and were much relished. Vinegar was allowed the inmates on days when bacon, cabbage, or greens were served. Salt was always placed on the tables, but pepper was generally added in the kitchen to the articles which required it. So far as could be ascertained, the inmates received no desserts of any sort except on certain holidays, when a complete change was made in the dinner menu.

The women inmates drank a good deal of tea, but on the whole coffee was the beverage of the institution. The latter was served twice a day, namely, at breakfast and at supper, and was made from a combination of Rio coffee and roasted rye, a mixture not uncommon in many homes in the locality. Sugar and milk were not placed on the tables, but were added to the coffee when it was made. This method, while it appeared to be the only one practicable, had the disadvantage of not suiting the individual preferences regarding the

quantity of sugar and milk. It was learned that an attempt was once made to put sugar on the table and let the men help themselves, but this was found impracticable. It would seem that in such an institution arrangements might be made whereby one person at each table might have charge of the milk and sugar and give each one at the table the amounts which suited his taste. Otherwise, the coffee seemed to be fairly satisfactory. The amount of milk used in it was greater or less according to the season, as the institution depends upon its own herd of cows for its milk supply. At the time of these studies (spring, 1905) about 8 gallons of milk were used in making up approximately 150 gallons of coffee. The amount of sugar used for this quantity was about 38 pounds.

Bread was the only article of food supplied in absolutely unlimited quantities to every person. Nevertheless, the aim was to provide enough of other foods so that there should be plenty for second or even third helpings for all who desired them.

In apportioning the soup and coffee to the different departments, the cook served what he considered sufficient amounts, measuring the quantities with his dippers, which he knew held a certain number of rations. The quantities served were in accordance with the number of people in each department, with an allowance, based on experience, for extra helpings. Similarly, the meat served on Mondays and Thursdays was cut up into rations and these rations counted out and apportioned according to the number of persons, some allowance being made for extra helpings. The cook's judgment in this matter was very good. There were very seldom calls at the kitchen for extra supplies, and, on the other hand, the amounts left over were very small.

The diet throughout the summer was varied by the use of different vegetables in their season. One practice at Bayview, namely, the method of distributing radishes, green onions, etc., was interesting, inasmuch as it is not customary, or at least it was not followed at other institutions in which dietary studies have been made under the auspices of this Office. If there were not enough vegetables at any one time to supply the whole institution, the supply first at hand was given, say, to the women's dining room, then the next lot to the men's dining room, and so on in rotation. In some institutions an article, even if it grows in the institution garden, is not commonly used unless there is enough to serve the whole institution at the same time.

MENUS FOR THE DIFFERENT WARDS.

The four dietary studies made at Bayview included by no means all the different classes of inmates. It is of interest, therefore, to give some data regarding the general menus, to show both the kinds of food used and the variations in the rations of different wards of the institution. These menus were of necessity very simple, and since

they were made at a time of the year when there was little variety in the vegetables available, indicate a simpler diet than was really served, taking the year through. It should also be remembered that at Bayview, as in most institutions, the Sunday and holiday meals varied from those of other days. On Sunday soup was not served, but meat (generally salt smoked pork or shoulder) and vegetables were provided, and on regular holidays, special dinners. Thus on Thanksgiving turkeys are served, and on Christmas, New Year's, and Fourth of July, special menus are provided.

A menu, selected as a fair sample of those served in the insane department, follows:

SAMPLE MENU OF INSANE DEPARTMENT.

Breakfast: Bread, coffee.
Dinner: Beef soup[a] with vegetables, bread, rice.
Supper: Bread, stewed fruit, coffee.

A sample menu for the hospital ward follows:

SAMPLE MENU OF HOSPITAL WARD.

Breakfast: Oatmeal, milk, bread, butter, eggs, tea, and coffee.
Dinner: Chicken soup, beefsteak, bread, tea.
Supper: Bread, butter, crackers, milk, tea, and coffee.

The menus for the phthisical ward and for the chronic patients were of the same general character.

A sample menu for the infirmary ward or "general diet" follows:

SAMPLE MENU FOR INFIRMARY (OR GENERAL DIET).

Breakfast: Oatmeal, milk, bread, butter, eggs, tea, and coffee.
Dinner: Beef soup with vegetables, bread.
Supper: Bread, coffee.

The character of meals served the working women is shown by the following sample menu:

SAMPLE MENU FOR WORKING WOMEN.

Breakfast: Oatmeal, milk, Hamburg steak, bread, butter, tea, and coffee.
Dinner: Bacon, beef soup with vegetables, rice, milk, bread.
Supper: Bread, butter, tea, and coffee.

The farm and stable helpers received the infirmary diet, together with a sort of meat and vegetable stew, called "hash," for breakfast each morning, cold beef for supper each evening, and molasses Tuesday evening at supper.

According to these menus the diet of the department for the insane appears to have been more varied than that of any other departments of Bayview excepting the hospital wards. Many of the inmates were

---

[a] See p. 19.

physically vigorous, and the Bayview officials evidently shared the belief commonly held that the insane need a fairly generous diet. The diet in the insane ward did not differ very much from hospital diets of public insane hospitals, as reported in previous studies made under the auspices of this Department [a] and similar work.[b] Rice and oatmeal were used extensively, both being well cooked. In the hospital ward the diet was naturally quite different from that in either the insane wards or the wards for regular inmates, being fitted to the needs of the individual patients. Eggs and milk were, of course, much used there.

There is no question that the diet supplied the regular population (with the exception of the hospital wards) was less varied than that of many hospitals for the insane. It is interesting to note in this connection that when inmates were first received they were, as a rule, satisfied with the food, but after a time they did not relish it so much. This was very likely due, in large measure, to the monotony of the diet.

Apparently the menu as a whole was as good as was possible with the amount of money available; and if the institution authorities are to provide a more varied diet more money will be required. If more money could be allowed for the purpose the diet could be easily and materially improved. There are a number of inexpensive dishes which are commonly used in insane hospitals which could be suggested for use here and which, introduced at least one day in a month, would make a comparatively small increase in the cost per year to the asylum. Such changes are, for example, the addition of baked beans to the regular supper menu once each month. Ginger cake might also be used for supper once a month, along with the regular bread and coffee, and would give a pleasing variety to the diet, particularly as nothing in the nature of a dessert is served except on holidays. Baked chopped hash would be a new and inexpensive dish that might readily be supplied. It would seem, too, that potatoes should be served with fish, as that accords with the custom in this country. While the bread served is very good, the occasional use of rolls or biscuits would vary the diet and make very little difference in cost. Frankfort sausages would also give a pleasing variety. Macaroni, prepared with tomatoes or cheese, would make a very palatable and nutritious dish at a very small cost. It is altogether probable that some such small additions to the menu would be of value as a source of greater contentment, even though they were not absolutely needed for nourishment.

---

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 150.

[b] N. Y. State Com. Lunacy Ann. Rpt., 11 (1898-9); 12 (1899-1900); 13 (1900-1).

METHODS OF MAKING THE DIETARY STUDIES.

The weights of foods served, returned, and wasted during these studies were recorded in the usual way; the methods of cooking were noted; the composition of the different foods was determined as described on page 15; and the number of persons served in the dining rooms under consideration was noted for each meal. From these data has been deduced the nutritive value of food served, eaten, and wasted per man or per woman per day, as shown in the tables beyond. Observations of general conditions were also made as an aid to interpreting the data.

One variation from the usual custom has been made in presenting the results of the investigation. It has been usual to record the amounts of nutrients and energy per man per day. In these studies, however, only the figures for protein and energy are given, these constituting the essential data for considering the nutritive value of the ration and related questions. The tables, therefore, do not show the relation of fats and carbohydrates to the diet. While such data might be interesting, they are not essential, since in the ordinary mixed diet it may be safely assumed that fats and carbohydrates will appear in reasonable proportions, and, furthermore, on theoretical grounds, it is immaterial, at least within limits not exceeded in these diets, which of these classes of foods supplies the energy, provided the total quantity is sufficient.

DIETARY STUDIES NOS. 682 AND 683, MEN'S DINING ROOM, REGULAR PATIENTS AND STABLE HANDS AND CHRONIC AND SPECIAL DIET PATIENTS.

Dietary studies Nos. 682 and 683 were carried on simultaneously in the men's dining room, which is the largest in the institution and in which several classes of persons are served. The total number served at the time the studies were made included 16 farm and stable helpers, 135 regular inmates, 82 chronic patients, and 24 men on special diet. In the winter the number served in the dining room is considerably larger. Study No. 682 included the regular patients and the stable hands and No. 683 the chronic and special diet patients.

During the week covered by these studies the chronic population included in study No. 683 did not vary from day to day. There was a very marked decrease, however, in the number supplied with the regular diet and included in study No. 682, the exact number for each day of the week covered by the study being as follows: Monday, 144; Tuesday, 143; Wednesday, 140; Thursday, 136; Friday, 132; Saturday, 128, and Sunday, 127.

The majority of inmates in this dining room were classed as workers, though the amount of work they did was, of course, very variable.

It has been stated above that the population of Bayview was composed almost entirely of men and women ranging from middle life to old age. In this dining room the so-called chronic patients were almost all elderly and decrepit, while the large majority of the regular inmates were men in middle life or older. The officer in charge of this dining room (himself an inmate of the institution) gave it as his opinion that the number of men under 50 years of age constituted a very small fraction of the total number.

The dining room was well cared for and clean. The food was served on bare, unpolished wooden tables, which were frequently washed and scrubbed with great care. The menu for the regular, chronic, and special diet patients was principally the same, but the chronic patients were supplied, in addition, with some articles which the regular inmates did not receive, and the special-diet patients had extra articles on order of the physician in charge. The farm and stable helpers had somewhat different food from the other inmates of this dining room, being allowed meat three times a day and potatoes with dinner on several days of the week. The meat and potatoes were frequently served together in a dish called "hash," though it was really a beef stew. Soup and coffee were served in tin cups, crockery plates being provided for other food. The ration system was followed entirely in this dining room except in the case of bread, that is, each man's share of the different kinds of food was served to him from the large lots sent from the kitchen and put at his place at the table. Bread was sliced and placed in square tin pans, three or four to a table, so that each man might help himself.

Meals were served as follows: Breakfast at 6 a. m., dinner at 12 m., and supper at 5.50 p. m. In the winter season there was not room for all the men to eat at the same time; the chronic patients were therefore served about twenty minutes earlier than the others and finished in time to let all the regular patients sit down together. In general no attempt was made to keep separate the amount of bread served to each person or the amounts of individual waste. The waste bread from the chronic patients was, however, kept separate for the different meals of one day, and the amount weighed. This, it is believed, gave a very fair idea of the average waste of bread from this department, as there appeared to be little variation in the amount from day to day. The results of the study with regular patients and stable hands are summarized in the table which follows, and show the amounts of protein and energy in food eaten and wasted for seven consecutive days of three meals each, the results being given separately for each day of the week. This method of tabulating the data gives an opportunity to observe the variation in food consumption on different days.

Amounts of protein and energy in food eaten and wasted per man per day, dietary study No. 682.

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
SUPPER, MAY 7, TO DINNER, MAY 8.				
Animal food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Beef, roasted (18) [a]	3	21		
Beef, boiled (1)	41	381		
Milk (33)	2	31		
Total animal food	46	433		
Vegetable food:				
Bread (4)	55	1,273	4	103
Sugar (46)		97		
Potatoes (baked) (64) [a]	1	33		
Sauce, evaporated apples (13)	1	222		12
Total vegetable food	57	1,625	4	115
Miscellaneous food:				
Soup (6)	17	522	1	20
Hash (80) [b]	5	72		6
Broth from soup (11)			1	8
Total miscellaneous food	22	594	2	34
Total food for 3 meals	125	2,652	6	149
SUPPER, MAY 8, TO DINNER, MAY 9.				
Animal food:				
Pork, shoulder, boiled (23)	23	424		
Milk (33)	2	32		
Total animal food	25	456		
Vegetable food:				
Bread (4)	66	1,527	3	74
Sugar (46)		100		
Total vegetable food	66	1,627	3	74
Miscellaneous food:				
Soup (15)	36	561		4
Hash (80) [b]	6	91		2
Broth from soup (11)			1	7
Total miscellaneous food	42	652	1	13
Total food for 3 meals	133	2,735	4	87
SUPPER, MAY 9, TO DINNER, MAY 10.				
Animal food:				
Beef, roasted (19) [a]	4	55		
Pork, shoulder, boiled (23)	22	406		
Milk (33)	2	33		
Total animal food	28	494		
Vegetable food:				
Bread (4)	64	1,481	3	79
Sugar (46)		102		
Radishes (68)	1	17		
Total vegetable food	65	1,600	3	79
Miscellaneous food:				
Soup (15)	39	608		
Hash (80) [b]	5	80		
Total miscellaneous food	44	688		
Total food for 3 meals	137	2,782	3	79
SUPPER, MAY 10, TO DINNER, MAY 11.				
Animal food:				
Beef, boiled (1)	41	377		
Beef, roasted (19) [a]	9	117		
Pork, shoulder, boiled (23)	19	345		
Milk (33)	1	34		
Total animal food	70	873		

[a] Served only to farm and stable helpers.
[b] This was a thick stew of potatoes and meat. It was served only to farm and stable helpers.

Amounts of protein and energy in food eaten and wasted per man per day, dietary study No. 682—Continued.

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
SUPPER, MAY 10, TO DINNER, MAY 11—continued.				
Vegetable food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Bread (4)	67	1,544	3	72
Sugar (46)	....	96	....	....
Potatoes, boiled (65)[a]	1	29	....	....
Total vegetable food	68	1,669	3	72
Miscellaneous food:				
Soup (6)	19	514	....	....
Hash (80)[b]	6	87	....	....
Broth from soup (11)	....	....	1	6
Total miscellaneous food	25	601	1	6
Total food for 3 meals	163	3,143	4	78
SUPPER, MAY 11, TO DINNER, MAY 12.				
Animal food:				
Pork, shoulder, boiled (23)	19	359	....	....
Herring, baked (28)	68	969	....	....
Milk (33)	2	40	....	....
Total animal food	89	1,368	....	....
Vegetable food:				
Bread (4)	74	1,707	3	70
Sugar (46)	....	155	....	....
Total vegetable food	74	1,862	3	70
Miscellaneous food: Hash (80)[b]	6	87	....	5
Total food for 3 meals	169	3,317	3	75
SUPPER, MAY 12, TO DINNER, MAY 13.				
Animal food:				
Butter (31)[a]	....	34	....	....
Milk (33)	2	54	....	....
Total animal food	2	88	....	....
Vegetable food:				
Bread (4)	69	1,585	4	92
Sugar (46)	....	101	....	....
Radishes (68)	1	28	....	....
Total vegetable food	70	1,714	4	92
Miscellaneous food:				
Soup (7)	51	523	....	....
Hash (80)[b]	6	87	....	....
Total miscellaneous food	57	610	....	....
Total food for 3 meals	129	2,412	4	92
SUPPER, MAY 13, TO DINNER, MAY 14.				
Animal food:				
Beef, roasted (19)[a]	4	54	....	....
Pork, shoulder, boiled (23)	52	963	....	....
Milk (33)	2	34	....	....
Total animal food	58	1,051	....	....
Vegetable food:				
Bread (4)	70	1,611	5	119
Sugar (46)	....	103	....	....
Cabbage sprouts, boiled (5)	12	282	....	....
Potatoes, boiled (66)	4	139	....	....
Total vegetable food	86	2,135	5	119
Miscellaneous food: Hash (80)[b]	5	80	....	....
Total food for 3 meals	149	3,266	5	119
Average per day for entire study	144	2,901	4	97

[a] Served only to farm and stable helpers.
[b] This was a thick stew of potatoes and meat. It was served only to farm and stable helpers.

The data given in the above table for dietary No. 682 show very clearly that there is a decided difference in the amount of nourishment received from day to day by the average subject, the quantities for individual days ranging from 125 grams to 169 grams of protein and from 2,412 to 3,317 calories of energy. The average for the seven days was 144 grams protein and 2,901 calories of energy per day. These figures are rather noticeable, since they show a somewhat narrower nutritive ratio than has usually been found in the dietary studies made under the auspices of the Office of Experiment Stations,[a] i. e., the proportion of protein to the energy is quite large. As is discussed in some detail elsewhere (p. 40), the subjects of this study were apparently well nourished. It seemed to the observer that in these studies the amounts of food consumed by different individuals varied greatly. Some inmates really consumed very little, while others were hearty eaters. This means that the individual consumption varied more from the average than in studies previously reported.

The amount of waste in study No. 682 was nearly uniform for each day of the study, and the daily average, 4 grams protein and 97 calories of energy—only 3 per cent of the total amounts supplied—is remarkably small not only for institution but even for family dietaries. The reason for such a small amount of wasted food is discussed on page 36. One point which should be noted in this and the following dietary studies is that the soup wasted was in many cases wholly or in part of different composition from that consumed, because the inmates ate nearly all the solid matter of the soup and left the broth. When both soup and soup broth remained the total waste was weighed and the proportion of broth estimated. A sample of this waste broth was analyzed and its percentage composition used for computing the nutritive value of all the waste broths. While this method is not strictly accurate, it is the only one which seemed practicable and is certainly much more accurate than to assume that the waste had the higher composition of the thick soup served. These waste portions of the soup had but little nutritive value, being largely fluid.

The general conditions under which dietary study No. 683 with chronic patients and those on a special diet, served in the men's dining room, was made, were spoken of in connection with dietary study No. 682, the two studies, as has been said, being carried on at the same time. The results of the study are summarized in the table which follows.

---

[a] See U. S. Dept. Agr. Office Expt. Stas. Cir. 89.

Amounts of protein and energy in food eaten and wasted per man per day, dietary study No. 683.

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
SUPPER, MAY 7, TO DINNER, MAY 8.				
Animal food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Beef, boiled, with gravy (17)	41	553		
Eggs, boiled (30)	2	24		
Butter (31)		158		
Milk (33)	9	188		
Total animal food	52	923		
Vegetable food:				
Oatmeal, boiled (2)	5	139		
Bread (4)	24	562	2	38
Sugar (46)		98		
Total vegetable food	29	799	2	38
Miscellaneous food:				
Soup (6)	18	521	1	18
Broth, from soup (11)				5
Total miscellaneous food [a]	18	521	1	23
Total food for 3 meals	99	2,243	3	61
SUPPER, MAY 8, TO DINNER, MAY 9.				
Animal food:				
Eggs (30)	2	25		
Butter (31)		158		
Milk (33)	9	185		
Total animal food	11	368		
Vegetable food:				
Oatmeal, boiled (2)	4	130		
Rice, boiled (3)	3	168		
Bread (4)	26	587	2	38
Sugar (46)		100		
Total vegetable food	33	985	2	38
Miscellaneous food:				
Soup (15)	35	556	1	10
Broth, from soup (11)				6
Total miscellaneous food [b]	35	556	1	16
Total food for 3 meals	79	1,909	3	54
SUPPER, MAY 9, TO DINNER, MAY 10.				
Animal food:				
Eggs (30)	2	25		
Butter (31)		158		
Milk (33)	10	198		
Total animal food	12	381		
Vegetable food:				
Oatmeal, boiled (2)	5	139		
Sugar (46)		100		
Bread (4)	25	587	2	38
Radishes (68)	1	18		
Sauce from evaporated apples (14)	1	140		
Total vegetable food	32	984	2	38
Miscellaneous food: Soup (15)	31	497		
Total food for 3 meals [c]	75	1,862	2	38
SUPPER, MAY 10, TO DINNER, MAY 11.				
Animal food:				
Beef, boiled, with gravy (17)	42	554		
Eggs (30)	2	25		
Butter (31)		158		
Milk (33)	9	197		
Total animal food	53	934		

[a] Of this, 7 grams of protein and 150 calories of energy were served to special-diet patients only.
[b] Of this, 8 grams of protein and 156 calories of energy were served to special-diet patients only.
[c] Of this, 8 grams of protein and 161 calories of energy were served to special-diet patients only.

Amounts of protein and energy in food eaten and wasted per man per day, dietary study No. 683—Continued.

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
SUPPER, MAY 10, TO DINNER, MAY 11—continued.				
Vegetable food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Oatmeal, boiled (2)	5	141		
Bread (4)	25	584	1	41
Sugar (46)		98		
Total vegetable food	30	823	1	41
Miscellaneous food:				
Soup (15)	34	532		
Broth from soup (11)			1	8
Total miscellaneous food	34	532	1	8
Total food for 3 meals [a]	117	2,289	2	49
SUPPER, MAY 11, TO DINNER, MAY 12.				
Animal food:				
Herring, baked (28)	70	939		
Eggs (30)	2	25		
Milk (33)	10	198		
Butter (31)		158		
Total animal food	82	1,320		
Vegetable food:				
Oatmeal, boiled (2)	5	139		
Rice, boiled (3)	3	174		
Bread (4)	25	587	2	37
Sugar (46)		155		
Total vegetable food	33	1,055	2	37
Total food for 3 meals [b]	115	2,375	2	37
SUPPER, MAY 12 TO DINNER, MAY 13.				
Animal food:				
Eggs (30)	2	25		
Butter (31)		158		
Milk (33)	10	209		
Total animal food	12	392		
Vegetable food:				
Oatmeal, boiled (2)	5	138		
Bread (4)	25	587	2	38
Sugar (46)		100		
Radishes (68)	.1	28		
Sauce from evaporated apples (14)	1	143		
Total vegetable food	32	996	2	38
Miscellaneous food: Soup (7)	38	383		
Total food for 3 meals [c]	82	1,771	2	38
SUPPER, MAY 13, TO DINNER, MAY 14				
Animal food:				
Pork shoulder, boiled (23)	27	485		
Eggs (30)	2	25		
Butter (31)		158		
Milk (33)	7	150		
Total animal food	36	818		
Vegetable food:				
Oatmeal, boiled (2)	4	131		
Bread (4)	25	587	2	37
Sugar (46)		103		
Cabbage sprouts, boiled (5)	17	382		
Potatoes, boiled (65)	2	61		
Total vegetable food	48	1,264	2	37
Total food for 3 meals [d]	84	2,082	2	37
Average per day for entire study [e]	93	2,076	2	45

[a] Of this, 7 grams of protein and 159 calories of energy were served to special-diet patients only.
[b] Of this, 8 grams of protein and 167 calories of energy were served to special-diet patients only.
[c] Of this, 8 grams of protein and 172 calories of energy were served to special-diet patients only.
[d] Of this, 5 grams of protein and 106 calories of energy were served to special-diet patients only.
[e] Of this, 7 grams of protein and 153 calories of energy were served to special-diet patients only.

The figures recorded in the table for food eaten and wasted by the chronic inmates present a striking contrast to those in the table on page 27, though all these subjects received their meals in the same dining room. The amount of protein in the ration of the chronic and special diet patients varied from 75 to 117 grams, and the energy from 1,771 to 2,375 calories per man per day, the average for the seven days covered by the study being 93 grams protein and 2,076 calories energy. These amounts are very much smaller than was the case with the regular patients in dietary study No. 682, the energy value being especially low.

The amount of waste in this study, as in the preceding, was extremely small, the average for the week being but 2 grams protein and 45 calories energy per day, or 2 per cent of the total amount of each supplied. These figures, like those in the preceding study, are very small and will be discussed beyond (see p. 35).

DIETARY STUDY NO. 684, WOMEN'S DINING ROOM.

Dietary study No. 684 was made in the women's dining room with 110 women, on an average, and 3 men who also had their meals there. Of the total number of subjects only about 55 were classed as workers, though nearly all did more or less work. A large number of the women were elderly; in fact, the majority had passed middle life and some were very old. The ration system (see p. 25) was followed in this as in the men's dining room. Part of the food served was cooked in the "county kitchen" and part in the "diet kitchen," while some of the extra allowance of meat for the workers was supplied from the officers' kitchen. It was not found practicable to obtain the weights of the food of the working women as distinguished from that of the others, so the weighings were made for the whole group. It is believed, however, that this does not introduce any great error in the final results, as certainly over half of the group were workers and the amount of extra food did not constitute a very large proportion of the total diet.

The dining room was similar in all essentials to that in the men's ward, as was also the service.

The data showing the amount of protein and energy in eaten and wasted food in the women's dining room during the week covered by the study are shown in the following table, the quantities being expressed on the basis "per woman per day." In computing the results the food of the 3 men was considered equivalent to that of 4 women.

Amounts of protein and energy in food eaten and wasted per woman per day, dietary study No. 684.

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
SUPPER, MAY 14, TO DINNER, MAY 15.				
Animal food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Beef, boiled (1)	28	257		
Eggs (30)	2	19		
Butter (31)		112		
Milk (33)	12	267		
Total animal food	42	655		
Vegetable food:				
Oatmeal, boiled (2)	2	70		
Bread (4)	33	745	6	152
Sugar (46)		131		
Total vegetable food	35	946	6	152
Miscellaneous food:				
Hash (80)	8	128		
Gravy (12)	2	58		
Soup (8)	4	143		
Broth from soup (11)			1	12
Total miscellaneous food	14	329	1	12
Total food for 3 meals [a]	91	1,930	7	164
SUPPER, MAY 15, TO DINNER, MAY 16.				
Animal food:				
Hamburg steak (20)	7	57		
Eggs (30)	2	19		
Butter (31)		109		
Milk (33)	13	286		
Total animal food	22	471		
Vegetable food:				
Oatmeal, boiled (2)	2	64		4
Rice, boiled (3)		31	1	25
Bread (4)	32	734	6	138
Sugar (46)		127		
Radishes (68)	2	39		
Total vegetable food	36	995	7	167
Miscellaneous food:				
Gravy (12)		18		
Soup (9)	22	319		
Broth from soup (11)			1	15
Total miscellaneous food	22	337	1	15
Total food for 3 meals [b]	80	1,803	8	182
SUPPER, MAY 16, TO DINNER, MAY 17.				
Animal food:				
Pork, shoulder, boiled (23)	11	194		
Eggs (30)	2	18		
Butter (31)		108		
Milk (33)	12	259		
Total animal food	25	579		
Vegetable food:				
Oatmeal, boiled (2)	2	62		7
Bread (4)	34	775	4	89
Sugar (46)		126		
Total vegetable food	36	963	4	96
Miscellaneous food:				
Soup (15)	14	233		
Broth from soup (11)			1	13
Total miscellaneous food	14	233	1	13
Total food for 3 meals [b]	75	1,775	5	109

[a] Of this, 4 grams of protein and 58 calories of energy were served to special-diet patients only.
[b] Of this, 4 grams of protein and 57 calories of energy were served to special-diet patients only.

***Amounts of protein and energy in food eaten and wasted per woman per day, dietary study No. 684*—Continued.**

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
SUPPER, MAY 17, TO DINNER, MAY 18.				
Animal food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Beef, boiled, with gravy (17)	48	643		
Pork, shoulder, boiled (23)	8	148		
Eggs (30)	2	18		
Butter (31)		108		
Milk (33)	12	255		
Total animal food	70	1,172		
Vegetable food:				
Oatmeal, boiled (2)	2	61		6
Bread (4)	34	787	3	78
Sugar (46)		126		
Onion tops, spring onions (59)	1	57		
Sauce from evaporated apples (14)	1	60		
Total vegetable food	38	1,091	3	84
Miscellaneous food:				
Soup (15)	15	241		
Broth from soup (11)			1	16
Total miscellaneous food	15	241	1	16
Total food for 3 meals[a]	123	2,504	4	100
SUPPER, MAY 18, TO DINNER, MAY 19.				
Animal food:				
Herring, baked (28)	11	164		
Eggs (30)	2	18		
Butter (31)		108		
Milk (33)	13	260		
Total animal food	26	550		
Vegetable food:				
Oatmeal, boiled (2)	2	68		
Rice, boiled (3)	1	38		
Bread (4)	32	750	5	114
Sugar (46)		126		
Total vegetable food	35	982	5	114
Miscellaneous food:				
Soup (15)	16	253		
Broth from soup (11)			1	17
Total miscellaneous food	16	253	1	17
Total food for 3 meals[a]	77	1,785	6	131
SUPPER, MAY 19, TO DINNER, MAY 20.				
Animal food:				
Eggs (30)	2	19		
Butter (31)		108		
Milk (33)	12	250		
Total animal food	14	377		
Vegetable food:				
Oatmeal, boiled (2)	2	68		
Bread (4)	34	775	4	89
Sugar (46)		126		
Radishes (68)	2	40		
Total vegetable food	38	1,009	4	89
Miscellaneous food:				
Soup (15)	14	233		
Hash (80)	8	124		
Broth from soup (11)			1	14
Total miscellaneous food	22	357	1	14
Total food for 3 meals[b]	74	1,743	5	103

[a] Of this, 4 grams of protein and 56 calories of energy were served to special-diet patients only.
[b] Of this, 4 grams of protein and 55 calories of energy were served to special-diet patients only.

Amounts of protein and energy in food eaten and wasted per woman per day, dietary study No. 684—**Continued.**

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
SUPPER, MAY 20, TO DINNER, MAY 21.				
Animal food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Pork, shoulder, boiled (23)	16	293		
Eggs (30)	1	19		
Butter (31)		147		
Milk (33)	13	265		
Total animal food	30	724		
Vegetable food:				
Oatmeal, boiled (2)	2	53		
Bread (4)	34	782	4	[illegible]
Cabbage sprouts (5)	8	178	2	54
Sugar (46)		128		
Sauce from evaporated apples (14)		61		
Total vegetable food	44	1,202	6	132
Total food for 3 meals [a]	74	1,926	6	132
Average per day for entire study [a]	85	1,924	6	134

[a] Of this, 4 grams of protein and 57 calories of energy were served to special-diet patients only.

The data given in the table above show that the variations in the amounts of food consumed on different days of the week were considerable, as was the case in the two preceding studies. The average amounts eaten per woman per day, 85 grams protein and 1,924 calories of energy, are equivalent to 106 grams protein and 2,405 calories of energy when calculated on the basis per man per day (the daily food requirement of a woman being taken as 0.8 that of a man). That this ration furnished sufficient protein there can be but little question. The amount of energy furnished is, however, not proportionately high. Whether or not the amount was sufficient is discussed later (p. 40).

The 6 grams of protein and 134 calories of energy in the waste represent about 7 per cent of the total food served. This amount. though relatively larger than that noted in the other studies at Bayview. was small as compared with that in other institutions studied.

DIETARY STUDY NO. 685, MEN'S RECEIVING WARD.

Study No. 685 was made with 82 men in the men's receiving ward, which is located in the half basement of the main building. It is in this ward that the men are placed on coming into the institution. Some of the men included in this group were epileptics, some cripples, and some men in good health. There were a few young men, but most had reached middle age and some were aged. Judged by the amounts of food which were sent to this ward, these men on an average were hearty eaters, though very few of them appeared to be strong and healthy. Only 8 of the group were classed as workers.

The men in this dining room had their breakfast early, being through the meal by 6 in the morning. They had their dinner about 12 and their supper a little before 6 o'clock p. m.

The dining room and service did not differ in any important particular from those previously described.

The amounts of protein and energy consumed and wasted during the study are shown in the following table, the data being recorded for the entire period and not for the individual days, as was the case in studies Nos. 682, 683, and 684.

Amounts of protein and energy eaten and wasted, per man per day, dietary study No. 685.

Food materials.	Amounts eaten.		Amounts wasted.	
	Protein.	Energy.	Protein.	Energy.
Animal food:	*Grams.*	*Calories.*	*Grams.*	*Calories.*
Beef, boiled (1)	11	103		
Pork, shoulder, boiled (23)	4	71		
Butter (31)		36		
Milk (33)	4	80		
Total animal food	19	290		
Vegetable food:				
Bread (4)	54	1,234		3
Sugar (46)		99		
Cabbage sprouts, boiled (5)	3	69		
Onion tops, spring onions (59)		9		
Sauce from evaporated apples (14)		20		
Total vegetable food	57	1,431		3
Miscellaneous food:				
Soup (15)	35	553	1	6
Broth from soup (11)				2
Total miscellaneous food	35	553	1	8
Total food [a]	111	2,274	1	11

[a] Of this, 3 grams of protein and 76 calories of energy were served to special-diet patients only.

The results of this study show an average consumption of 111 grams protein and 2,274 calories of energy per man per day. The waste was less than 1 per cent of the food served, an extremely small proportion. In fact, it was so small that it was scarcely worth taking account of. It should also be noted that no food was returned to the kitchen. Usually all the food sent was eaten, but if any food was not served it was saved in the dining room for the next meal, or was eaten between meals.

WASTE.

The average amounts of waste for the three studies with men were about 2 per cent only of the average amount served, much less than is to be expected in institutions of this kind. Judging from the available data on this subject, one may fairly consider any waste under 8 or 10 per cent of the food served to be small. It would, there-

fore, seem that the management had decreased these amounts as much as possible without danger of undersupplying the inmates. The waste in the women's dining room, though somewhat larger than the average for the three studies with men, was still remarkably small.

The small amounts of waste may be due either to a lack of sufficient quantities of food, which tends to make the subjects consume all that is available for them, or to care on the part of the institution authorities in planning the quantities necessary so closely that all may have a sufficiency and yet nothing be wasted. In this connection it should be noted that the diet was peculiar in that the food served was of such a nature that it did not allow of much waste, unless the quantities served should be too great. Thus the meat which was served had all the bones removed before being sent to the tables, so that there was no loss from meat adhering to bones, while the bread which was not used could easily be returned for another meal (except such as was placed upon the individual plates). That the management had planned the diet with a view to avoiding waste was evident from the nature of the foods served, and, as has already been stated, it was apportioned to the several dining rooms with exceptional care and good judgment. That the subjects in study No. 682 had sufficient food can not be questioned, yet in this study the waste is as small as with the others. This would seem to show pretty conclusively that the very small waste was due to care in the selection and preparation of food on the part of the officials of the institution. Such a condition of affairs is eminently desirable in public institutions and speaks most highly for the management.

AMOUNT EATEN PER PERSON AS SHOWN BY TOTAL AMOUNTS PURCHASED.

As a means of learning more regarding the amount of food actually consumed in different dining rooms in the institution, it was thought best to estimate the quantity of nutrients and energy of the diet from the kind and amounts of food purchased for the inmates. To this end recourse was had to the books of the institution, and a table has been prepared showing the amounts of food annually purchased for the use of the inmates, and also the amount of farm products raised at Bayview for home consumption. From the data thus obtained, showing the total amount of food provided, the protein, fat, and carbohydrates supplied were calculated, as well as the average amount obtained per person per day. The data thus obtained form practically a dietary study for a year for all the inmates. Such data are especially useful where regular detailed studies of a large part of the population are not made, as was the case at Bayview, because they give some idea as to the average food consumption of all the inmates of the institution throughout the year. The data are summarized in the table following.

Food provided for inmates during entire year, and nutrients contained in it.

Reference number.	Food materials.	Total weight.		Protein.	Fat	Carbohydrates.
	ANIMAL FOOD.					
	Meats and fish:	*Pounds.*	*Kilograms.*	*Kilograms.*	*Kilograms.*	*Kilograms.*
16	Beef, fore quarter, lean	207,109	93,944.6	13,809.9	8,924.7	....
21	Mutton, side	26,000	11,793.6	1,533.2	2,830.5	....
22	Pork, side, not including lard and kidney	5,794	2,628.2	210.3	1,287.8	....
24	Bacon, shoulder, smoked, medium fat	46,072	20,898.3	2,716.8	5,558.9	....
25	Sausage	2,300	1,043.3	135.6	461.1	11.5
26	Poultry	2,148	974.3	133.5	119.8	....
27	Herring, fresh and salt	4,900	2,222.7	248.9	86.7	....
29	Eggs	25,358	11,502.4	1,506.8	1,069.7	....
	Dairy products:					
31	Butter	13,759	6,241.1	62.4	5,304.9	....
32	Cheese	3,867	1,754.1	454.3	591.1	42.1
33	Milk	260,018	117,944.2	3,892.2	4,717.8	5,897.2
34	Lard	800	362.9	....	362.9	....
	VEGETABLE FOOD.					
	Cereals:					
35	Wheat flour, spring and winter wheat	362,208	164,297.5	18,729.9	1,643.0	122,401.7
36	Hominy	1,100	499.0	41.4	3.0	394.2
37	Oats, rolled	6,048	2,743.4	458.1	200.3	1,816.1
38	Rice	11,933	5,412.8	433.0	16.2	4,276.1
39	Rice flour	196	88.9	7.6	5.4	60.5
40	Crackers, soda	2,043	926.7	90.8	84.3	677.4
41	Crackers, water	3,633	1,647.9	192.8	82.4	1,247.5
42	Cakes, mixed	714	323.9	28.2	27.9	241.3
43	Ginger snaps	2,027	919.4	59.8	79.1	698.8
	Sugars:					
44	Candy	680	308.4	....	....	296.
45	Molasses	10,212	4,632.2	111.2	....	3,210.1
46	Sugar	29,651	13,449.7	....	....	12,777.2
	Vegetables:					
47	Beans, pea, dried	3,758	1,704.6	383.5	30.7	1,016.0
48	Beans, Lima, dried	425	192.8	34.9	2.9	127.0
49	Beans, Lima, fresh	3,276	1,486.0	47.6	4.5	147.1
50	Beans, string	4,472	2,028.5	42.6	6.1	140.0
51	Beets	2,711	1,229.7	16.0	1.2	94.7
52	Cabbage	32,451	14,719.8	206.1	29.4	706.5
53	Carrots	8,921	4,046.6	36.4	8.1	299.4
54	Cauliflower	922	418.2	7.5	2.1	19.7
55	Celery	900	408.2	3.7	.4	10.6
56	Corn	10,481	4,754.2	57.1	19.0	366.1
57	Lettuce	378	171.5	1.7	.3	4.3
58	Onions	3,258	1,477.8	20.7	4.4	131.5
59	Onion tops, spring onions	878	398.3	4.0	.4	44.6
60	Parsley	72	32.7	....	....	....
61	Parsnips	10,206	4,629.4	60.2	18.5	500.0
62	Peas, green	1,188	538.9	19.4	1.1	52.8
63	Potatoes	133,688	60,640.9	1,091.5	60.6	8,914.2
67	Radishes	3,065	1,390.3	12.5	1.4	55.6
69	Ruta-bagas	10,714	4,859.9	43.7	4.9	291.6
70	Salsify	822	372.9	4.8	1.5	40.3
71	Sauerkraut	950	430.9	7.3	2.2	16.4
72	Spinach	1,733	786.1	16.5	2.4	25.2
73	Squash	9,007	4,085.6	28.6	8.2	183.9
74	Tomatoes	69,208	31,392.7	282.5	125.6	1,224.3
75	Turnips	22,501	10,206.5	91.9	10.2	581.8
	Fruits:					
76	Apples	775	351.5	1.1	1.1	38.0
77	Apples, dried	10,610	4,812.7	77.0	105.9	3,181.2
78	Peaches, dried	251	113.9	5.4	1.1	71.2
79	Prunes, dried	1,000	453.6	8.2	....	282.1
	Miscellaneous:					
	Coffee, Rio	26,053	11,817.6	....	....	....
	Rye (for coffee)	18,424	8,357.1	....	....	....
	Total	....	644,848.9	47,469.1	33,911.7	172,613.9
	Nutrients[a] per person per day	....	....	96	69	351

[a] These quantities would give a total of 2,398 calories per person per day.

In collecting such data no allowance could be made for amounts on hand at the beginning and end of the period covered by the figures, but it is believed that this does not introduce any great error, as the amounts were presumably not very different.

The table from its very nature is not entirely accurate, for the reason that in making it up a number of assumptions were necessary. The assumptions were, however, made as carefully as possible, largely with the help of one of the institution officials, and it is believed that they are not very far from the truth. In the first place, it was not always possible to obtain the amounts of foods purchased for inmates distinct from that purchased for employees, and in such cases estimates had to be made, based on the proportion of the two classes to one another. Also there were certain articles of food purchased which were not supplied to the inmates as a whole, but only to a certain number of them. Such, for example, are eggs, which were served almost exclusively to sick or infirm patients. In the second place, more or less error was unquestionably introduced in estimating the weights of the various articles which were recorded in bulk. Particularly is this true of the farm products, the data for which were taken from the report of the city board of charities for 1904. These products were given variously in bundles, bushels, heads, barrels, etc., the weights of which could not be accurately determined, since they may vary within considerable limits. However, it is not likely that the errors are important, since the farm products, which introduced the chief uncertainty, form only a minor part of the whole food supply for the entire year.

The data in the table (p. 37) show the total amounts of nutrients in the food consumed by the inmates during one year to have been, respectively, 47,469.1 kilograms protein, 33,911.7 kilograms fat, and 172,613.9 kilograms carbohydrates. By dividing these by 365, the number of days in a year, and the quotients thus obtained by 1,348, the average daily population of Bayview for the year ending December 31, 1904,[a] the amounts supplied per person per day are found, namely, 96 grams protein, 69 grams fat, and 351 grams carbohydrates, with a total fuel value of 2,398 calories.

As is discussed on page 36, the waste in this institution was very small, probably not greater, on the average, than 3 per cent of the food provided. Allowing for this proportion of waste, the amount actually eaten per person per day would be 93 grams protein, 67 grams fat, and 340 grams carbohydrates. These amounts are considerably smaller than the per capita allowance at the Government

[a] Since the table represents purchases of food from May, 1904, to May, 1905, this average does not represent precisely the same period. It is not believed, however, that the true figures would be enough different to change the results by more than one or two units either way.

Hospital for the Insane,[a] but the studies are not directly comparable, for the reason that the latter includes a far greater proportion of employees with very much greater muscular activity, and also for the reason that at Bayview the ratio of hospital patients, other than insane, to the total number of inmates is greater. It is interesting to note that the figures in the table (p. 37) agree closely with the standard (100 grams protein and 2,950 calories of energy) proposed by Atwater[b] for insane hospitals as regards protein, and show a somewhat smaller amount of energy than he proposed. These points will be more fully discussed later (p. 40).

COST OF THE FOOD.

It is interesting to compare the cost of the food per person per day at Bayview with similar data regarding other institutions and families. As nearly as this factor can be calculated, it was 6.94 cents per day. In nine public institutions studied by Mrs. Ellen H. Richards and Miss Sarah E. Wentworth[c] for the institution commissioner of Boston, the cost of food for inmates ranged from 5.29 to 9.89 cents per person per day. In the institutions which may perhaps be most properly compared with Bayview, namely, the Long Island and the Charleston almshouses, it was 7.54 and 7.73 cents, respectively.

In families where such data have been recorded in connection with the dietary investigations carried on under the auspices of this Office, the cost of food per person per day has shown considerable range, being very low in a number of cases and very high in others. In the case of families living in the thickly congested districts of New York, Chicago, and Philadelphia, many of them of the type ordinarily receiving aid from charitable organizations, the cost of food has ranged from 9 cents to 42 cents per person per day. With families living in rural regions, the cost has been 5 to 28 cents. With families of professional men and others in similar circumstances, a range of 22 to 40 cents per person per day has been noted. With college students and college clubs the range has been from 17 cents to 97 cents. Judged by these values, which, though not numerous enough for final deductions, may yet be fairly regarded as showing something of the actual cost of food, it will be seen that the diet at Bayview was very low in cost.

---

[a] U. S. Dept. Agr., Office Expt. Stats. Bul. 150.

[b] Dietetics in Relation to Hospitals for the Insane. U. S. Dept. Agr., Office Expt. Stas. Rpt. 1904, p. 473.

[c] Rpt. Inst. Comm. [Boston], 2 (1897), p. 206.

RESULTS OF DIETARY STUDIES AT BAYVIEW.

The principal objects of the dietary studies in the old-age home, as previously stated, were to secure data regarding the amounts of nutrients and energy in the diet of the aged men and women, and to learn something of the adequacy and suitability of the dietary with a view to supplying information which would be of value in judging of the institution food situation as a whole, and for making changes in the dietaries, should this seem necessary and desirable, and also for the collection of data of use in general discussions of nutrition problems.

It is difficult to compare the results of studies at these institutions with dietary standards, since the activity of the different individuals of any given group varied very greatly. If the commonly accepted American dietary standards are to be used, it is necessary to select a standard for each group which will, so far as possible, conform to the amount of muscular work performed by the average individual of the group studied, and in making such a selection it seems better to err on the side of too high values than too low, as every precaution should be taken in institution dietetics to avoid any tendency toward underfeeding.

For the dietary study with regular patients and stable hands who had their meals in the men's dining room (study No. 682), the standard for a man performing light to moderate work, namely, 112 grams protein and 3,050 calories of energy, seems best for purposes of comparison. This group undoubtedly included the most active of the men studied, yet it was evident that they did not perform an amount of work equivalent to the average day's labor in the factory or on the farm. The diet corresponds with the standard selected very closely as regards energy and exceeds it as regards protein. While the amount of protein was not excessive when we consider that the time covered by the dietary study was short, and that, perhaps, the amount at other times would be somewhat less, there is no reason to suppose that these men could have required more protein than an average man outside the institution receives in his food.

The ration allowance computed from the food purchased for a year, namely, 96 grams protein and 2,398 calories of energy, was probably amply sufficient when we recall that the proportion of invalids and hospital-ward patients was large, as was also the proportion of aged and infirm inmates.

For the chronic and special diet patients included in dietary study No. 683, it seems hardly fair to use a standard for persons in health, since it is believed that the group did not represent the conditions which the standard is intended to cover. It seems certain that these men and women had all they could eat of the food provided, and

although they might have been tempted by a more varied diet to eat larger amounts, yet it does not seem at all probable that the energy supplied was insufficient for their needs, although it is somewhat lower than the value, 2,700 calories, for a man of sedentary occupation. On the other hand, the protein requirement is in almost exact accord with the amount included in this standard.

Dietary study No. 685, with men in the receiving ward, shows a food consumption of 111 grams of protein and 2,274 calories of energy. The subjects were not nearly as active as those of study No. 682, who obtained somewhat larger amounts of protein and energy, and it seems that their food requirements could not have been greater than those of "men with very little muscular exercise," namely, 90 grams of protein and 2,450 calories of energy, according to the commonly accepted American dietary standards. Judged by these values the dietary may be considered adequate as regards protein and energy. There were a number of young men in this group whose food consumption would naturally be greater than that of the old men in studies Nos. 682 and 683, and this probably accounts for the greater average amounts of food eaten.

Dietary study No. 684, made with women inmates, shows that the amounts of protein and energy obtained were 85 grams and 1,924 calories, respectively, per woman per day. Only half the women included in this group were classed as workers. Some of them were undoubtedly quite active, yet it seems fair to say that, considering the group as a whole, the degree of muscular activity was not great. The suggested dietary standards for women performing light to moderate muscular work call for 90 grams protein and 2,450 calories of energy, and the suggested standard for women having light exercise, 80 grams protein and 2,250 calories. Perhaps the best values for comparison with the group studied would be an average of these two standards, namely, 85 grams of protein and 2,350 calories of energy per day. Compared with such values, the results obtained with the group of women studied show close agreement as regards protein, but a deficiency of about 400 calories as regards energy. The standard selected for the comparison refers to women in full bodily vigor, but many of those studied, as previously stated, were aged and infirm. When it is also remembered that the general health and appearance of the women of this group remained as good as usual, it does not seem probable that the diet supplied less nutritive material than was required. It would be a simple matter, however, to increase the energy value by adding some simple dishes to the menu, as stated above.

One reason for believing that the women included in dietary study No. 684 received sufficient food for their needs is that the waste, though relatively small, was greater than was noted in the other

studies made at Bayview. It is a matter of general observation that where the food is of good quality little, if anything, will be wasted unless more is provided than is required.

In general, it may be said that if the rations had not been sufficient for the inmates, losses in weight would have been very commonly noted and the physical condition of the inmates would not have been maintained. Many of the inmates were aged and infirm, and they naturally become more feeble with each year that passes; but it was the opinion of the officers in charge of the institutions that, as a whole, the inmates maintained their physical condition and showed improvement rather than the reverse, which would indicate that the food supplied sufficient nutritive material for their body needs. Especial pains were taken to learn the opinions of the inmates regarding the sufficiency of the food supplied, and no one was found who expressed a belief that the dietaries were insufficient. The food was necessarily simple, and no great variety was possible at Bayview, and this lack of variety was frequently commented upon. A number of the inmates expressed dissatisfaction with some particular dish, but such complaints were neither uniform nor general, so it seems perhaps fair to assume that the dietary was reasonably well relished. Taken all in all, the dietaries here considered can fairly be considered as adequate when judged by the condition of the subjects fed, by comparison with commonly accepted dietary standards, and by comparison with the results obtained at other institutions and with the results of individual studies made with aged people.

There is no reason to suppose that the amounts of nutrients and energy furnished during the time these dietary studies were made differed very greatly from the amounts for other seasons, though it must be remembered that the studies were made in the late spring, a season which is perhaps least well calculated to give an especially favorable impression of the diet, since at this time of the year the vegetables stored for winter use are practically exhausted and the new crops have not matured. As fresh vegetables are high at this time of the year, they are, of course, hardly available, since the institution funds warrant the purchase only of staple foods of reasonable price. For these reasons it seems possible that the studies reported represent the minimum rather than the average amounts and the more meager rather than the more generous menus. With the more varied diet made possible by a freer use of vegetables, it is very probable that larger amounts of suitable foods would have been eaten owing to better appetite. The amounts of food necessary to bring the dietaries up to the standards as regards energy are relatively small. For instance, had the subjects of dietary study No. 685 received an ounce more of bread per meal, the energy value of the ration would have been somewhat more than 2,450 calories per day. A pound of

ginger cake per person per week would have brought up the energy value of dietary No. 683 sufficiently to make it conform to the Voit standard.

It is presumable that in the Bayview studies the aged persons ate less than the young and that dietary studies of individuals would have shown considerable variation from the average values for the group. If the group could be subdivided on a basis of age, it seems very probable that the diet could be more carefully adjusted to the actual needs of individuals. Such a change would mean somewhat smaller amounts for the aged, with little muscular work, and for the younger persons amounts which would conform to the commonly accepted standards suggested for persons performing an equivalent amount of muscular work. If the groups could be so subdivided, special attention should be paid to providing soft foods and light and easily digested dishes for the aged. Changes like those suggested would necessarily mean that more time must be spent in the preparation of food and would very probably mean an increase in the cost of the diet.

In discussing the Bayview almshouse dietaries it is interesting to note data regarding the Baltimore almshouse, reported some fifty years or more ago by J. S. Gould.[a] The data recorded include the bill of fare and in most cases the quantities served. The daily fare for nonworkers consisted of 8 ounces of bread with coffee for breakfast and a like amount of bread with tea for supper. On Mondays in winter dinner consisted of mush and molasses and in summer of rice and molasses. On Tuesdays and Thursdays 8 ounces of mutton made into soup and 4 ounces of bread made up the dinner and on Wednesdays and Saturdays 8 ounces of beef made into soup and 4 ounces of bread. The Friday dinner, like the Monday dinner, was mush or hominy and molasses. On Sunday 5 ounces of bacon or pork was provided and presumably 4 ounces of bread. Workers received in addition to the above 12 ounces of fresh meat or 9 ounces of bacon per day. In calculating the nutritive value of the soup it was assumed that a small quantity of potatoes or some similar material was used in its preparation, as is almost always the case, and it was necessary to make some assumptions regarding the amounts of mush and molasses eaten. Average values for the composition of the different foods were used in computing the nutritive value of the rations. As calculated, the dietary for nonworkers furnished 78 grams protein and 1,959 calories of energy and the diet for workers 85 grams of protein and 2,067 calories of energy per man per day, values smaller as regards both protein and energy than those in the average of the four studies made at Bayview.

[a] A Report on Food and Diet Suited for Almshouses, Prisons, and Hospitals. New York, 1852, p. 79.

As may be seen from the figures in the table (p. 83), the different groups studied at Bayview received in their daily fare about the same quantities of protein and energy as the groups studied at the New York State hospitals for the insane, the Massachusetts almshouses, the Munich homes for the aged, and the Scotch poorhouses, where pauper lunatics are cared for. It will be seen that the Bayview dietaries contained somewhat more protein than the average of the dietaries regarded as deficient and somewhat less energy. No data were reported regarding the number of aged persons in the Scotch institutions, but it is perhaps fair to assume that no considerable number of them were aged and infirm persons, and the difference in the nutrients and energy value of the respective dietaries is perhaps explainable on this basis, as there is reason for believing that the Bayview dietary was as adequate as the dietaries considered adequate in the Scotch institutions.

In order to compare the rations in these dietaries with the maintenance rations suggested by Maurel it would be necessary to know the weights of the subjects. Unfortunately, it was not feasible to have the subjects weighed during any of the studies, but 25 average-sized inmates of each sex were weighed at Bayview a few months later and the average weight of the men was found to be 145 pounds (66 kilograms) and of the women 118 pounds (54 kilograms). Assuming these figures to be applicable to the whole institution, the weights would indicate that the men averaged about 60 years of age and the women slightly more. Maurel's maintenance ration for the men, then, would call for 82 grams of protein and 1,965 calories of energy, and the average Bayview ration supplied in excess of this 39 grams of protein and 539 calories of energy, amounts amply sufficient for the slight external activity of the subjects. In the case of the women, the dietaries supplied 18 grams of protein and 312 calories of energy more than Maurel's maintenance ration for a woman of 70 years weighing 54 kilograms—probably ample protein and excessive energy for the slight external muscular work performed.

In planning institution dietaries, whether for the aged, the middle-aged, or the young, humanity demands that some account be taken of the comfort as well as the bare nutritive requirements of the inmates, especially when they have become wards of the public through no fault of their own. To what extent the dietitian is justified in going beyond the minimum ration which is consistent with safety, or beyond the minimum cost for the sake of variety, must depend upon the character of the institution and the funds at its disposal. There are, however, many methods by which variety can be increased with little or no increase in cost.

Dunlop,[a] in a discussion of some of the essential points of a good institution dietary, states that it must contain a sufficient quantity of energy-yielding food and sufficient protein as compared with the commonly accepted dietary standards, and that it shall not contain an excess of carbohydrates or, in other words, fat and carbohydrates must be present in a reasonable ratio. The inmates must be classified, both as to sex and the amount of work performed. The diet must be divided into meals of reasonable amount, must be of sufficient variety and pleasing, must contain a sufficient amount of condiments and a fair allowance of potatoes or other fresh vegetables.

In dietary studies which were undertaken in Scotch prisons by him,[b] it was observed that the subjects lost weight and were discontented with a ration which supplied less energy than the usually accepted dietary standards called for, and that when this deficiency was made good by increasing the bread allowance somewhat, the complaints ceased and weight was maintained. In the Scotch institutions studied it seems probable that no large proportion of the inmates were aged and infirm, and this may account for the fact that they seemed to require somewhat larger amounts of energy for maintenance than the groups studied in Baltimore. In planning institution dietetics it is obvious that the aim should be to supply too much food rather than too little, as the inmates should not be generally undernourished. As previously noted (p. 21), bread was supplied at Bayview, so the inmates could have increased the energy value of their diet by eating more bread, if the appetites were not satisfied. If it seemed desirable to increase the energy somewhat by providing some food which would supplement the energy value of the diet in a more appetizing way than an increased consumption of bread, this could be readily done with little expense by adding gingerbread occasionally to the dinner or supper menu, or some other inexpensive dish, like macaroni cooked with cheese or tomatoes, or baked beans. These dishes, which commonly form a part of the diet in many public institutions, would also increase the proteid value of the dietary and would undoubtedly do much to relieve the monotony of the diet and add to its palatability.

To secure the needed variety in institution dietetics Dunlop[a] states that changes in the dinner menus must be relied upon to a great extent, and supper and breakfast almost always of necessity consist of bread and tea or coffee or some similar combination. To secure this variety in the dinners he suggests that no individual soup, broth

[a] Report on dieting of pauper lunatics in asylums and lunatic wards of poorhouses in Scotland. Ann. Rpt. Gen. Bd. Comrs. Lunacy Scot., 43 (1902), Sup.
[b] Scot. Med. and Surg. Jour., 8 (1901), p. 405.

excepted, should be served oftener than twice a week; that the meat and the method of cooking it should be varied, boiled beef being served not oftener than three times weekly. Puddings, sweetened and flavored, should be supplied at times. The same menu should not be served oftener than twice a week, and the weekly routine should be periodically revised and made to include seasonable dishes. Rhubarb, apples, etc., should be used when readily procurable. Such factors were considered in planning the Bayview rations, and in the other homes for the aged where studies were made it was possible to pay even more attention to such matters, as the resources were more abundant.

When dietary conditions at Bayview were made a subject of special attention several years before the dietary studies reported in this bulletin were carried on (p. 18), a number of changes were introduced which added much to the comfort of the inmates, and which are of a sort which should always be possible when needed, as they do not involve increased expenditure. For instance, cereal breakfast foods were introduced as a breakfast dish in place of some of the bread previously issued, and were much appreciated by aged persons to whose needs soft foods are especially suited. Recognizing the fact that the flavor of browned meat is very appetizing to most palates, care was taken to provide at intervals meat thus cooked, instead of meat boiled in soup, which is such a universal dish in public institutions. Other similar changes were made in the menus which, though inexpensive and entailing little additional labor, added much to the palatability of the diet.

DIETARY STUDIES IN HOMES FOR THE AGED AND ORPHAN ASYLUMS UNDER PRIVATE MANAGEMENT.

The five studies in institutions in Baltimore reported in the following pages were conducted a year later than those at Bayview, and the data were collected by H. L. Knight of this Office. Three of the studies (Nos. 686 to 688) were made in homes for the aged under private management, one (No. 690) in an orphan asylum of the same character, and one (No. 689) in an orphan asylum supported largely by public funds. Each study lasted seven days. The general method followed was that sometimes known as "the family method," and described in detail in previous publications of this Office.[a] Records were made of all the kinds and amounts of food on hand at the beginning of the study, of those brought into the institution throughout its course, and of those remaining at the end. The difference between the first two and the last amounts was assumed to represent the food provided for the period under consideration. The refuse—that is, the

[a] U. S. Dept. Agr., Farmers' Bul. 142; Office Expt. Stas. Bul. 150.

inedible material in some foods, such as bones, prune pits, eggshells, etc.—was, in most instances, separated and weighed, its amount being deducted from the weights of the foods as purchased to give the quantities of edible materials. In all such cases analyses of the edible portions of the foods are utilized in calculating the amount of nutritive material. In those instances in which determination of the amount of refuse was impracticable, recourse was had to analyses of materials as purchased. The waste was in each case carefully weighed and a composite sample retained for analysis, except in study No. 689, where the entire amount was saved and analyzed. The nutrients in the waste were calculated and subtracted from those found for the total food provided, and the difference was taken as the total amount eaten. The amount consumed per inmate per day was determined in the usual manner, by dividing the total food consumed by one-third of the aggregate number of meals served, due allowance being made for difference in sex, age, activity, etc., although in some instances the presence of groups of persons whose relative nutritive requirements were somewhat doubtful introduced complications which will be explained in connection with the individual studies.

Supplementary information as to the age, activity, body weight, etc., of the inmates was obtained whenever practicable.

DIETARY STUDY NO. 686.

The home for aged women in which this study was made is under the control of a board of management representing a Baltimore philanthropic association, which delegates the immediate charge to a house matron, assisted by a room matron and a nurse. The institution is supported largely by private funds, but the State makes an annual appropriation of $3,000 for the joint use of this home and the affiliated home for aged men. Candidates for admission must be 60 years of age or over, the preference being given to older women; they must be of good character and without husband or children. An entrance fee is required varying from $200 to $300 according to the age of the applicant. For residents of other States than Maryland there is an additional charge of $500. At the time of the study there were 75 inmates, all that the home could accommodate.

The building is a large three-storied brick structure erected about fifty years ago. It was in good condition but not modern. The kitchen, pantry, storerooms, and dining room were in the basement. At the time of the study a new range had just been installed in the kitchen, but there were few labor-saving devices, such as bread-mixing machines, bread slicers, etc. The dining room was large, well lighted, comfortably furnished, and well adapted to its purpose,

and was kept neat and clean. There were seven small tables seating from 6 to 12 persons each.

Meals were served at 7 a. m., 1 p. m., and 6 p. m., from April 1 to October 1, and at 7.30 a. m., 1 p. m., and 5 p. m. the remainder of the year. All inmates physically able were required to be present punctually. The attendance at meals varied considerably, not only on account of inability to come to the dining room, but because the inmates were generally allowed to visit friends outside the institution.

Those unable to come to the table were served in their rooms just before the regular meal hours. During the study about 20 women were thus served, though few of these were actually ill. The management hoped soon to install a passenger elevator in the building; with such an arrangement many of the inmates who are too feeble to climb stairs could have come to the dining room regularly. Since the completion of the study an elevator has been provided.

According to the rules of the home the "inmates are expected to make themselves useful in such ways as their services may be valuable for the benefit of the home." A few took care of the corridors, pared potatoes, and occasionally washed dishes, but in most cases they showed little inclination to do more than care for their own rooms and mend and iron their clothes.

The servants, 1 man and 7 or 8 women, were all negroes. The kitchen force consisted of a skillful and industrious cook and 3 helpers, who washed dishes, waited on table, etc. At the time of the study the house matron had but recently been appointed.

PURVEYING OF FOOD.

As there were no cold-storage facilities little attempt was made to buy in large quantities. The matron bought the meats and vegetables each day from the neighboring markets. Groceries were purchased twice a week, butter and eggs weekly. Potatoes were obtained by the bushel, flour and sugar by the barrel, and coffee and tea in 25-pound bags. It was a point of pride with the matron that the food purchased was invariably of good quality. Friends of the institution frequently sent donations of canned goods, fancy cookies, fruit, vegetables, and occasionally turkey or other such delicacy, and ice cream. These donations arrived somewhat irregularly; nevertheless it seemed to be the policy of the institution to depend upon them in considerable measure for the luxuries and variety of the table. In the opinion of the matron less than usual was sent in during the week of the study. The inmates were strictly forbidden to buy or solicit food from outside, as it was thought this might give the institution an undesirable reputation, but nevertheless some was undoubtedly smuggled in. The visitors who were allowed on Thursday and Friday afternoons also brought delicacies to their friends among the inmates. It was, of

course, impossible to determine how much was obtained in these two ways. One attendant thought it was as much as 10 per cent of the food eaten, but this estimate is probably too large. A good share of the inmates had no money, and careful observation indicated that while a few individuals received a not inconsiderable portion of their food in this way the average amount was not large. Moreover, the food thus obtained was mostly fruit, the nutritive value of which would be even less significant than the quantity. It seems safe to assume, therefore, that no great error is introduced into the results of this study by such unrecorded materials.

KINDS OF DIET.

The sick were given special diets when necessary, but at the time of the study there was little actual illness, and the meals served in the inmates' rooms differed from those in the dining room principally by the addition of jelly. Eggs, either raw or boiled, were furnished to any inmate who desired them in the place of meat at breakfast or dinner. Tea was served at each meal, and an alternative of coffee was offered at breakfast and supper.

The matrons and attendants ate in the dining room immediately after the inmates had finished. Their diet was the same as that of the inmates, except that they occasionally bought for themselves small amounts of fruit, vegetables, etc., for the sake of variety. These were not included among the foods measured, because they were believed to be in excess of the regular diet; that is, the matron and attendants ate the regular diet plus these supplemental foods, and to disregard them seemed to give a more accurate average for the institution.

No special diet was provided for the servants, who were expected to make their meals of what was left after the others had been served. They complained that this was frequently insufficient, and it is undeniable that the supply of one or more articles was sometimes exhausted in the dining room. There was always, however, an unlimited supply of bread.

METHOD OF SERVING.

Most foods were placed on the tables in large dishes and the inmates allowed to help themselves. Bread was provided ad libitum at all meals, as were milk and sugar for the tea and coffee. Butter, oatmeal, some vegetables, and fruit were served in individual portions. A second helping was allowed when practicable, but was seldom called for.

UTILIZATION OF REMNANTS.

Since the food returned from the tables was largely consumed by the servants, but little had to be utilized in other ways. Any butter

remaining on the butter plates was collected after the meal by the matron and used in cooking. The sliced bread, of which considerable quantities were returned from the table, was allowed to accumulate until there was enough to serve either fried as "French toast" or toasted. Twice during the study bread which had become very dry was thrown away by the servants, but this was contrary to the matron's orders.

AGE, WEIGHT, AND HEIGHT OF INMATES.

Unfortunately it was impracticable to get definite information on these points during the study. Ten months later the secretary of the home reported that the minimum age of inmates was 65, the maximum 90, and the average 76 years, and these statistics had probably not been materially altered by deaths or new admissions since the study was made. The high minimum age is significant. While women may be admitted at 60, the number of applicants is so great that they are rarely taken at ages under 65.

There was no opportunity to weigh the inmates during the study, and the only way of obtaining an idea of their weight was to estimate it by carefully noting the size of the women as they passed into the dining room. This was done on two successive days, and as the inmates entered in different orders on the two days and the two estimates were very similar, it is thought worth while to note the estimated average, namely, 131 pounds. To estimate their height a mark was made 5 feet from the ground on the post of the doorway through which the inmates entered, and the height of each woman was estimated as she passed through. The figures obtained in this way averaged 5 feet 1 inch. Of course both these measurements are too crude to have any but a most general significance.

The character of the meals served during the study is indicated by the following sample menu:

MENU FOR SATURDAY, MAY 12, 1906.

Breakfast: Pork sausage, fried; rolled oats, tea, coffee, butter, bread, milk, sugar.

Dinner: Potatoes, boiled or baked; spinach, beefsteak, bread, butter, sugar, milk, tea.

Supper: Gingerbread, white bread, tea or coffee, milk, butter, sugar.

ATTENDANCE.

One day was spent in preliminary observations at the home; the study proper began with dinner on May 11, 1906, and was continued for a full week of 21 meals. During that time 967 meals were served to inmates at the main table, 414 to inmates in their rooms, 52 to attendants, 143 to female servants, 17 to male servants, and 2 to the observer, making a total of 1,595, or the equivalent of one person for

532 days. While the attendants and servants undoubtedly ate more than the inmates, the difference is not believed to be sufficiently large to introduce a significant error if ignored in the calculation of the results of the study, and so no attempt has been made to include such a correction in calculating the results.

A word of explanation should perhaps be given concerning the material designated "Food unused at end of study" in the table following. This represents either foods which had been returned from the dining room and would be utilized at later meals, or, as in the case of tallow, parts of the raw materials set aside during their preparation. Since it forms part of the food measured, its nutrients must, of course, be subtracted from those of the total food in order to determine the amounts actually consumed, but it is in no wise to be considered as waste.

Weight of total food, and protein and fuel value of food per woman per day, dietary study No. 686.

Kinds and amounts of food materials.	Amounts per woman per day. Protein.	Fuel value.
ANIMAL FOOD.		
	Grams.	*Calories.*
Beef: Ribs, 23.88 pounds (2); round, 35.19 pounds (4); shoulder and clod, 9.31 pounds (6); steak, Hamburg, 12.44 pounds (11); dried, salted, and smoked, 7 pounds (13)	15.7	177
Lamb: Leg, 21.31 pounds (15)	3.5	42
Pork: Fresh chuck, ribs, and shoulder, 22.44 pounds (19); ham, fresh, 21.50 pounds (20); shoulder, smoked, 41.44 pounds (26)	11.1	321
Sausage: Pork, 13.06 pounds (34)	1.4	52
Fish: Weakfish, 24.38 pounds (36); cod, salt, 6.56 pounds (38); herring, salted and smoked, 36.25 pounds (39)	16.2	116
Eggs: 25.50 pounds (41)	2.6	30
Dairy products: Butter, 18.44 pounds (42); cheese, full cream, 3.31 pounds (43); milk, 430 pounds (44)	13.0	163
Lard: 17.38 pounds (47)		138
Total animal food	63.5	1,039
VEGETABLE FOOD.		
Cereals: Corn meal, granular, 13.31 pounds (50); oats, rolled, 25.44 pounds (53); rice, 4.19 pounds (55); wheat flour, 253.19 pounds (59); macaroni, 5.06 pounds (63)	28.9	939
Sugars, etc.: Molasses, 9.75 pounds (77); sugar, granulated, 93.19 pounds (79)	.2	349
Vegetables: Greens, dandelion, 14.44 pounds (91); lettuce, 8.25 pounds (94); onions, 2 pounds (95); potatoes, 216.13 pounds (100); rhubarb, 13.88 pounds (102); spinach, 19.13 pounds (105); tomatoes, canned, 15.13 pounds (111)	4.3	146
Fruits: Lemons, 0.50 pound (117); peaches, dried, 6 pounds (121); raisins, seeded, 2 pounds (125); plums, preserved, 9.19 pounds (129); jelly, plum, 0.75 pound (132)	.3	41
Total vegetable food	33.7	1,475
Total food	97.2	2,514
FOOD UNCONSUMED.		
Unused at end of study: Beef, roast, cooked 2 pounds (9); ham, smoked, fried, 0.94 pound (25); herring, fried, 1.06 pounds (40); tallow, 1.75 pounds (4.8); oats, rolled, cooked, 2 pounds (54); bread, wheat, 24.88 pounds (66); peaches, stewed, 0.75 pound (122)	2.9	83
Waste: 200.25 pounds (139)	9.0	225
Total food unconsumed	11.9	308
Total food consumed	85.3	2,206

WASTE.

The waste from each meal was weighed, run through a meat chopper, and thoroughly mixed; a 10 per cent sample was then removed for analysis, a few drops of a 40 per cent solution of formaldehyde being added to prevent decomposition. In this study kitchen and table waste were measured and analyzed together, amounting in all to 200 pounds 4 ounces, and containing about 10 per cent of the protein and energy of the food. While this is not a large proportion as compared with that found in many public institutions, it is somewhat higher than that in the other studies of this series. At least a partial explanation lies in the fact that so many meals were served to the inmates in their rooms. Since there was no chance for a second helping in these cases, it was necessary to send up generous portions, considerable quantities of which were returned uneaten, and for sanitary reasons thrown away. In order to determine how great was this loss, the waste returned from the private rooms was kept separate from that from the kitchen and dining room. It was found that the total waste from the kitchen and dining room was but 96 pounds 3 ounces, a little less than one-half the total. On the other hand, that from the separate meals, which served less than one-third of the total population, was 104 pounds 1 ounce, of which 22 pounds 5 ounces was bread, 28 pounds 12 ounces solid food other than bread, and 53 pounds liquid waste, chiefly tea and coffee, to which milk and sugar had been added. The wasted bread alone contained 932 grams protein and 27,814 calories of available energy, or about 20 per cent of the nutrients of the total waste. As long as the present practice of serving so many meals in rooms was continued, this source of waste seemed likely to remain, for it would have been a difficult matter to decrease the size of the portions served without giving offense. Now that the desired passenger elevator has been installed, this loss should be considerably diminished. At the time of the study, meals were sent up to about 20 inmates, of whom all but 5 or 6 could have come to the dining room in an elevator, and not only the labor of serving them in their rooms but also considerable food could thus have been saved.

ADEQUACY OF THE DIET.

An earnest attempt was made to get the frank opinion of the inmates regarding the diet at the home, and no complaints were made as to the quantity of food. The desire to obtain special food from outside might seem an indication of insufficient rations, but the true reason probably lay rather in the wish to secure variety and luxuries, which the institution could not be expected to furnish. Careful observation of the inmates gave no reason to suppose that they were not abundantly supplied with the necessary food.

As regards the amounts of protein and energy actually eaten, the table (p. 51) shows them to be 85 grams of protein and 2,206 calories of energy per woman per day. These figures are almost identical with the proposed standard—85 grams protein and 2,200 calories energy. Such a very close agreement, of course, has no special significance, but since there is no reason to suppose that the diet in this study was not well adapted to the needs of its subjects, it may be considered a corroboration of the standard.

COST AND SELECTION OF FOOD.

According to the report of the home for 1906 the expenditure for provisions during that year was as follows: Meats, $1,630.74; poultry and fish, $342.76; milk, butter, eggs, and ice, $1,466.54; groceries, $1,115.63; vegetables, $533.48; making a total of $5,089.15. Judging by the cost of the ice used in the men's home, it may fairly be assumed that $100 was spent for this item in the women's home; subtracting this from the total sum, we find the amount expended for food alone to be $4,989.15. With an average population of 76 this is equivalent to $1.26 per inmate per week, or 18 cents per day.

While this amount is larger than that found in the German Aged Peoples' Home (see p. 59), it can not be considered excessive for the quality of the food provided. A diet supplying equal amounts of nutrients at less cost could easily be selected, but it is very doubtful whether such a change would prove either acceptable or wise. The situation in this home is not that in a free public institution. The inmates in general have come from comfortable homes and have paid a considerable sum on admission; they would be justified therefore in demanding a certain amount of the more expensive foods which give variety in the diet. While it was the policy of the institution to pay considerable attention to economy, an effort was also made to provide foods of the same general character as those to which the inmates had been accustomed before their admission. For example, it was a peculiar feature of the diet that very few of the cheaper cuts of meat, particularly those suited for soup making, were used; the matron feared that the introduction of such materials would arouse dissatisfaction, as savoring somewhat of the practice in the institutions for the poor. Whether or not this prejudice could be overcome is an open question. Such meats are very palatable when used as well-seasoned stews, as beef a la mode, and in similar ways, and of course often appear on the table of families in comfortable circumstances. It would seem to an outsider that money might occasionally have been saved in this way and expended, say, for desserts, of which none were regularly provided. Similarly, the use of tub butter in the place of pound prints for table use, and the substitution of something cheaper for cooking, would have made a considerable saving without

rendering the food less attractive. Another minor point is also suggested by a study of menus. Rolled oats were served every morning as breakfast cereal, and there was some complaint of monotony. While the oats are probably as cheap as any cereal, the occasional substitution of a similar wheat or corn preparation, or even of a ready-to-eat cereal, would have obviated this criticism without adding more than a few cents to the cost of the meal. An unsuspected source of loss was brought to light by the study; previously, the weight of goods purchased had not been checked on their arrival at the home, and when they were weighed by the observer it was found that some of the dealers were sending short measure; the matron at once procured a pair of spring balances and stopped this practice.

It should be remembered that many items of the diet came as gifts from friends of the institution and are not included in the expenditures. As they include practically all the more expensive materials, their money value must have amounted to a considerable sum during the year, a fact which should be borne in mind in comparing the cost in this and other studies. From the point of view of the dietitian it would probably have been more convenient to receive the money equivalent of such gifts and expend it for similar luxuries at discretion rather than to depend on the irregular donations in kind for this part of the diet. It may well be, however, that the more direct personal interest which such donations foster between an institution and its friends more than compensates for the inconvenience. As was previously stated, the matron thought that these gifts were less numerous than usual during the week of the study.

Other conditions may also cause slight variations in the character of the diet from week to week, but it is believed that if due allowance be made for the season of the year, the results of this study are fairly typical of the usual diet. All things considered, they indicate that the institution was getting a fair return for its expenditures for food.

DIETARY STUDY NO. 687.

The home for aged men in which this study was made is under the same management as the home for aged women (see study No. 686), and the regulations under which its inmates are received and governed are practically the same as in that institution. At the time the study was made it was in charge of a man and his wife who had served as superintendent and matron for seventeen years. They were aided by an assistant matron and 6 negro servants, 2 men and 4 women. The building, which adjoins the home for aged women, resembles it in general appearance and arrangement, though it was erected ten years later, and is smaller, accommodating only 50 inmates. The kitchen, storerooms, and dining room are in the base-

ment. The kitchen and storerooms are small, and contained few labor-saving devices beyond a bread mixer. As in the women's home, a dumb-waiter connects with the upper stories. In the dining room was one long table, at which the inmates were served. The men left the table as quickly as they pleased, often remaining no longer than ten minutes and seldom more than fifteen. The superintendent and matrons had a small private dining room, in which they ate just after the inmates had finished. The servants ate in the kitchen, their food consisting largely of what was left from serving the main table.

At the time of the study there were 41 inmates, 3 of whom were aged women, who were temporarily accommodated here because of insufficient room in the women's home. Their meals were served in their rooms, as were those of 8 men too infirm to go to the dining room.

As in the women's home, the inmates showed little inclination to do any work beyond taking care of their rooms, though 2 of the men regularly wiped the dishes. The bodily activity of the men was probably a trifle greater than that of the women in the previous study. Ten months after the study the minimum age in the home was reported as 60, the maximum 89, and the average 75, and there is no reason to suppose that the figures had changed much in the interim.

PURVEYING OF FOOD.

The marketing was done daily by the superintendent, who showed good judgment in following the market and taking advantage of any favorable prices. The food purchased was invariably of good quality. Although the men's home depended largely upon donations for its delicacies, these seemed less frequent than in the women's home. Much less food was brought in by the inmates than in study No. 686.

KINDS OF DIET.

Whenever it was needed, a special diet was served to the sick, in which eggs, jellies, etc., were freely used. The attendants varied the regular diet by small amounts of fruit, etc., but not to any great extent. Such articles and the "extras" served to the sick are not listed in the menu, but are included and specially marked in the table on page 57; as they were eaten mainly in small proportions in excess of the regular diet, they were not considered in estimating the amounts of nutrients consumed per man per day.

METHOD OF SERVING.

The food was prepared mainly by the matron and her assistant, and was well cooked and neatly served. Most of the articles were

placed on the table in large dishes, from which the inmates helped themselves. Bread was supplied ad libitum, and a second helping of most other things allowed. The men were expected to eat everything on their plates, and usually did so. Butter was served in individual portions at breakfast and supper, but not at all at dinner. Milk and sugar were added to the tea and coffee and the cereals before serving. Milk was considered too expensive ever to be used as a beverage.

UTILIZATION OF REMNANTS.

As in the previous study, most of the food returned from the serving dishes on the tables was consumed by the servants. The butter remaining on the plates after all had finished was used to spread on the bread for the infirm and blind, a practice which seems unnecessarily economical.

The kind of meals served during the study is indicated by the following sample menu, which has been selected as a fair average:

MENU FOR MAY 19, 1906.

Breakfast: Irish stew (beef and potatoes), rolls, bread, butter, tea or coffee with milk and sugar.

Dinner: Roast mutton, boiled rice, lettuce salad, strawberries, sugar, bread, tea or coffee with milk and sugar.

Supper: Chipped beef with milk gravy, bread, butter, tea or coffee with milk and sugar, currant jelly.

ATTENDANCE.

After a day of preliminary observation the study began with supper on May 18, and was continued through 21 meals. During this period a total of 1,000 meals was served, 821 to men and 179 to women. The women in the home were of two classes, 5 attendants and servants and 3 elderly women who were awaiting transference to the women's home. While as a rule in such studies the food consumption of women is assumed to be 0.8 of that of men, this factor was not used. As regards the female attendants and servants, their bodily activity was so much greater than that of the inmates of either sex that if anything they ate more, rather than less, than the men. As regards the women inmates, their number was so small that no large error could be introduced in assuming that their food consumption differed very little from that of the elderly men. It therefore seemed most feasible to treat the population as homogeneous and to calculate the results on this basis, but to take the differences into account in interpreting them. Accordingly the figures per person per day in the following table were obtained by dividing the total amounts of protein and energy by 333, one-third of the total number of meals served.

Weight of total food, and protein and fuel value of food per man per day, dietary study No. 687.

Kinds and amounts of food materials.	Amounts per man per day.	
	Protein.	Fuel value.
ANIMAL FOOD.		
Beef: Chuck, including shoulder, 16.31 pounds (1); ribs, 10.81 pounds (2); round, 22.06 pounds (3); steak, Hamburg, 9 pounds (11); liver, 7.63 pounds (7); boiled, 9.44 pounds (8); dried, salted, and smoked, 6.69 pounds (13)	*Grams.* 23.9	*Calories.* 272
Mutton: Leg, 33.69 pounds (17); shoulder, 3 pounds (18)	9.0	120
Pork: Chuck, ribs, and shoulder, 18.5 pounds (19); ham, smoked and boiled, 15.44 pounds (24); backs, dry-salted, 16.44 pounds (27)	10.3	311
Sausage: Bologna, 5.69 pounds (30)	1.5	19
Fish: Cod, salt, 12.13 pounds (37)	4.2	15
Eggs, 37.56 pounds (41)	6.1	72
Dairy products: Butter, 21.44 pounds (42); milk, 142.38 pounds (44)	6.7	371
Gelatin, 0.38 pound (45)	.5	2
Lard, 7.06 pounds (47)	....	89
Total animal food	62.2	1,271
VEGETABLE FOOD.		
Cereals: Cornmeal, granular, 6.56 pounds (50); hominy, 3.56 pounds (51); oats, rolled, boiled, 2.13 pounds (54); rice, 4.81 pounds (55); rice, boiled, 1.13 pounds (56); wheat flour, 94.5 pounds (60); wheat breakfast food, rolled, steam-cooked, 4.81 pounds (62); bread, wheat, 30.25 pounds (66); rolls, 7.38 pounds (68); crackers, soda, 0.69 pound (70); pudding, bread, 2.13 pounds (75)	22.1	717
Sugars, etc.: Molasses, 5.25 pounds (77); sugar, granulated, 57.06 pounds (79); sirup, 2.75 pounds (77)	.3	350
Vegetables: Asparagus,[a] 1.19 pounds (81); cabbage, 26 pounds (83); lettuce, 4.88 pounds (94); onions, 11.75 pounds (95); potatoes, as purchased, 142 pounds (100); potatoes, edible portion, 7.88 pounds (99); rhubarb, 1.94 pounds (102); rhubarb, stewed,[a] 3.5 pounds (103); spinach, 7 pounds (105); peas, canned, 13 pounds (110); tomatoes, canned, 15.81 pounds (111)	5.8	185
Fruits: Bananas, 20.81 pounds (115); lemons, 1.5 pounds (117); oranges, 3.81 pounds[a] (118); strawberries, 14.94 pounds (120); peaches, dried, 5.88 pounds (121); prunes, 7.5 pounds (123); jelly, currant, 11.63 pounds (130); lemon, 0.94 pound (131)	1.1	120
Total vegetable food	29.3	1,372
Total food	91.5	2,643
FOOD UNCONSUMED.		
Unused at end of study: Beef and mutton, stewed, 7.13 pounds (138); pork, ribs, cooked, 1.94 pounds (22); fat, 7.19 pounds (46); pie, rhubarb, 1.06 pounds (74)	1.4	110
Waste, 114.38 pounds (140)	7.3	194
Total food unconsumed	8.7	304
Total food consumed	82.8	2,339

[a] Served only with special sick diet.

WASTE.

As is shown in the above table, the total waste during this study amounted to 114 pounds 6 ounces, or 8 per cent of the protein and 7 per cent of the energy of the food supplied. This amount is not large, as compared with that in many other institutions, and is smaller than that in the previous study. This difference is mainly due to the fact that the matron showed remarkably good judgment and tact in the size of portions sent to the rooms, and in this way cut down the amount of food returned uneaten. The waste in this study probably could not have been decreased appreciably, unless possibly in one or two minor ways. A considerable part of the food discarded con-

sisted of meat, which had evidently proved difficult for the elderly men to masticate; if such cuts could have been served in some softer form, such as stews or soups, of which the inmates seemed fond, some waste perhaps could have been prevented. As in many institutions, milk and sugar were added to the tea and coffee before serving. Whether or not this practice is of real economy is an open question which has been discussed in connection with other studies (see p. 20). In the present case it seemed to the observer that the amount of waste was increased rather than diminished thereby.

ADEQUACY OF THE DIET.

The amounts of nutrients and energy furnished per man per day in this study were found to be 82.8 grams of protein and 2,339 calories of energy. This amount of protein is two or three grams lower than the standard or the amount found per woman per day in the former study. This difference becomes slightly greater when it is recalled that in all probability the servants and attendants ate more than was credited to them in the calculations, so that the amount actually consumed by inmates was, if anything, lower than that given. The energy supplied is about 140 calories more than the standard. There was little complaint of any kind among the men regarding the character of the food and none whatever regarding the quantity. The natural conclusion therefore is that the standard of 85 grams of protein is abundantly high for men in the decline of life; as for the energy, all that can be safely said is that these men appeared contented and well nourished on an amount slightly higher than the standard.

COST AND SELECTION OF FOOD.

The amounts expended for food during the year are given in the report for 1906 as follows: Meats, $1,380.53; milk, butter, and eggs, $742.59; poultry, fish, and vegetables, $766.78; groceries, $797.25; miscellaneous marketing, $383.63; giving a total of $4,070.78. Assuming an average population of 48, the cost per man per week would be $1.63, or 23 cents per man per day. This amount is the largest found in any of the present studies, and is almost a third again as high as that found in the women's home. The reason for this is by no means apparent. The number of inmates was smaller, but the purchases were more frequently made in bulk, and apparently with better judgment and to better advantage than in the women's home. There may have been fewer donations, necessitating the purchases of more expensive materials, but the list of gifts as published in the annual report hardly sustains this explanation. On the other hand, butter was used only twice a day in this study, and the food consumption is lower, at least as regards the more expensive protein. The reason is

probably to be found, if at all, in the larger proportion of nutrients supplied by meats; in the first study these represent about 33 per cent of the protein and 24 per cent of the energy, while in the second they furnish 49 per cent of the protein and 27 per cent of the energy. Considering that some of the inmates were frequently unable to eat portions of the meat as served and expressed a preference for soups and stews, it would seem easy and desirable to reduce this item, substituting less expensive cuts for the roasts and steaks, or else using more milk and cheese and cereals. In this connection another minor suggestion may be made, namely, that a more frequent use of oatmeal at breakfast would be both acceptable and economical. In spite of these criticisms the fact remains that the diet here studied was well planned, well served, and gave decided satisfaction. An especially agreeable feature was the tact with which the matron succeeded in catering to the individual tastes of the inmates without disturbing the routine of the service or causing ill feeling; this personal consideration was manifested in other ways as well, and undoubtedly did much to produce the contentment noticeable among the inmates. As in the women's home, the conditions of entrance justified the use of a certain amount of luxuries in the diet, and its cost should not be judged by the same standards as that in charitable or penal institutions.

DIETARY STUDY NO. 688.

This study was carried on at the German Aged People's Home, in the western part of Baltimore. Although there are no restrictions as to nationality, the home is managed entirely by Germans and the inmates are almost all German. The State grants an annual appropriation of $1,500, and there are many annual subscriptions from German-American citizens. An admission fee of $200 is charged, and a considerable part of the annual income is also furnished by the inmates. Both men and women are received. The minimum age for admission is 60 years, but the applications are so numerous that few persons under 65 are admitted. The average number of inmates in 1906 was from 60 to 70; at the time of the study there were 27 men and 38 women.

The home occupies a large, commodious three-story brick building erected in 1885. It is pleasantly situated on a rise of ground, and has about half an acre of land in its rear, devoted to lawns, gardens, and a hen yard. A flock of about 30 hens is kept, being cared for by one of the inmates and fed in part on table waste.

The kitchen, storerooms, and pantry are in the basement, and except for the pantry, which is small and dark, they are large and well furnished. The equipment included a new range and a bread cutter, but few other modern labor-saving devices. A dumb-waiter runs from the kitchen to the dining room on the floor above. The

latter contains two long tables, one for the men and one for the women, and in all their appointments, like everything else at the home, are kept scrupulously clean and neat.

The matron, her assistant, and the five servants, all German, have their meals in a small dining room in the basement, usually before serving the others. Their diet was exactly the same as that given the inmates in the dining room.

Inmates too infirm to come to the main table were served in their rooms. A special sick diet was provided when necessary. During the study there was little real sickness.

Since the close of the study a passenger elevator, screens, a gas range, electric lights and fans, and a steam laundry have been provided. Additional improvements are contemplated.

PURCHASE OF FOOD.

The buying was done by the matron, who visited the markets almost daily. She showed good business ability, insisted on good quality, and took great pains to choose wholesome and economical food. A pair of scales was used to check purchases. Little or no food was donated to the home, gifts being made in money instead, a practice probably more satisfactory to the purveyor, as already pointed out.

AGE AND WEIGHT OF INMATES.

According to the report of the home for 1906, the average age of the 65 inmates then in the home was 78 years. An opportunity was given to weigh the inmates in the dining room at the close of one meal. The average weight of 18 men was 141½ pounds; of 29 women, 134 pounds; or an average weight of about 137 pounds for both sexes. Of course the more infirm were not weighed, but their weights would probably not have noticeably changed the average.

The character of the weekly menu is indicated by the menu for one day, which follows.

MENU FOR JUNE 5, 1906.

Breakfast: Smoked sausage, bread, butter, coffee with sugar and milk.

Dinner: Barley soup, lamb boiled, string beans, canned tomatoes stewed (left over from day before), potatoes, coffee with milk and sugar, bread.

Supper: Bread, butter, tea with milk and sugar.

ATTENDANCE.

Owing to the necessity of finishing the study before the approaching fiftieth anniversary celebration of the home, the usual day of preliminary observation was dispensed with. The study began with dinner on June 2 and continued through 21 meals. During this time 556 meals were served to men and 911 to women. Of the latter, how-

ever, 111 were served to female servants and the matron. As the activity of these women was much greater than that of the male inmates, it seems more reasonable to assume that the greater activity compensated for the difference in sex. The remaining 800 meals to female inmates were as usual assumed to be equivalent to 0.8 of that number for men. The total number of meals as served to male inmates would therefore be $556+111+(800\times0.8=640)=1{,}307$. This is equivalent of 1 man for 436 days. The protein and fuel value per man per day are given in the following table:

Weight of total food and protein and fuel value of food per man per day, dietary study No. 688.

Kinds and amounts of food materials.	Amounts per man per day.	
	Protein.	Fuel value.
ANIMAL FOOD.	*Grams.*	*Calories.*
Beef: Shoulder and clod, 68.94 pounds (6)	14.1	133
Veal: Leg, 29.75 pounds (14)	6.4	46
Lamb: Leg, 18.88 pounds (15)	3.8	46
Pork: Ham, smoked, 36.25 pounds (23); salt, lean ends, 0.88 pound (29)	6.3	168
Sausage: Frankfort, 14.38 pounds (31); pork, 18.44 pounds (32)	5.4	128
Fish: Cod, 28.06 pounds (35)	4.9	22
Eggs, 9.13 pounds (41)	1.1	13
Dairy products: Butter, 38.69 pounds (42); milk, 224.13 pounds (44)	8.1	487
Lard, 6.69 pounds (47)		65
Total animal food	50.1	1,108
VEGETABLE FOOD.		
Cereals: Barley, pearled, 1.31 pounds (49); corn meal, granular, 2.69 pounds (50); oats, rolled, 6.63 pounds (53); rice, 6.69 pounds (55); rye flour, 1.63 pounds (58); wheat flour, 129 pounds (60); farina, 1.06 pounds (61); bread, rye, 24.81 pounds (65); macaroni, 5.06 pounds (63); cake, 49.13 pounds (71)	25.2	885
Sugars, starches, etc.: Molasses, 0.63 pound (77); starch, corn, 0.31 pound (76); sugar, granulated, 50.94 pounds (79); sugar, powdered, 6.38 pounds (80)		248
Vegetables: Beans, string, 13.63 pounds (82); cabbage, 26.13 pounds (84); cabbage, boiled, 5.94 pounds (85); leeks, 1.56 pounds (93); lettuce, 7.06 pounds (94); onions, 6.81 pounds (96); potatoes, 198.38 pounds (99); corn, canned, 2.06 pounds (109); tomatoes, canned, 22.75 pounds (111); pickles, cucumber, 0.25 pound (114)	6.0	205
Fruits: Lemons, 1.56 pounds (117); strawberries, 26.63 pounds (120); grapes, preserved, 0.75 pound (128); pears, canned, 26 pounds (127)	.4	35
Beer,[a] 6 pounds (134)		3
Olive oil, 0.63 pound (135)		6
Total vegetable food	31.6	1,382
Total food	81.7	2,490
FOOD UNCONSUMED.		
Food unused at end of study: Ham, smoked and boiled, 1.44 pounds (24); codfish cakes, 0.50 pound (137); fat, 5.19 pound (46); bread, 11.31 pounds (66); noodles, 2.06 pounds (63)	1.9	93
Waste: Bread, 1.63 pounds (66); table waste, 148.50 pounds (142); kitchen waste, 79.13 pounds (141)	6.3	172
Total food unconsumed	8.2	265
Total food consumed	73.5	2,225

[a] A donation sufficient in amount for only a portion of the inmates.

WASTE.

The food wasted in this study was weighed in three forms: (1) A lot of bread weighing 1 pound 10 ounces thrown away as too dry to

use; (2) table waste weighing 148 pounds 8 ounces; and (3) kitchen waste weighing 79 pounds 2 ounces. The protein and energy wasted was only about 7 per cent of the total, a very creditable showing.

Most of the waste seemed unavoidable. Of course the bread could have been utilized if attended to in time, but this was a very small item and there is no reason to suppose it other than an accidental occurrence. On the whole, very great pains were evidently taken to reduce the waste to a minimum, and, as the data show, with commendable success. It should also be noted that the waste in this home was not thrown away as garbage, but used as food for the flock of hens and incidentally gave some return in this way.

On the other hand, there existed another probable source of waste which could not be measured. It was the custom to allow the inmates to take tea and coffee to which milk and sugar had been added to their rooms to be consumed when desired. Occasionally inmates were seen to take other foods from the table for the same purpose. It is not reasonable to suppose that all of this food was eaten. At the same time the waste was probably greater in bulk than in nutrients, as the tea and coffee contained only small amounts of actual food. While it could easily have been avoided altogether by doing away with the practice, it is a question for the management to decide whether or not this would be wise. The custom is said to be in accordance with the habits of many of the inmates prior to admission to the home and its abolition might arouse discontent. Quite likely the slight loss was justified as a means of making the inmates more contented. It is interesting to note that in Swedish old-age homes[a] it is the custom to allow the inmates to prepare their own breakfast (coffee and bread) and their afternoon coffee in their rooms, a practice in accord with their usual habits, and believed to contribute to their contentment and comfort without adding materially to the expense of the institution.

ADEQUACY OF THE DIET.

According to the table (p. 61) the protein and fuel value of the food actually eaten per male inmate per day during this study was 73.5 grams of protein and 2,225 calories of energy. This amount of energy is practically identical with the standard, 2,200 calories, but the protein is over 10 grams lower than the 85 grams which the standard calls for. Since in the calculations of this study the female inmates are considered as consuming only 0.8 of the food consumed by the males, and since it is doubtful whether in extreme age the food consumption of the sexes differs as much as this implies, the figures here, if they err at all, are too large rather than too small. Nevertheless, bearing the extreme age and light weight of the inmates in mind,

[a] Littell's Living Age, 7. ser., 17 (1902), p. 473.

it does not necessarily follow that the diet was inadequate, even as regards protein. They were not restricted as to the amount of food eaten at table and could have increased it had they wished. Moreover, many of them seemed to have private sources of supply through individual purchase or gifts. The observer several times noticed inmates bringing in food, and the table waste during the study contained 10 ounces of prunes, an orange, and several ounces of pretzels, none of which were provided by the home. It was of course quite impossible to estimate the amount of food thus obtained, but probably it introduced no large error, especially as it seemed to consist mainly of succulent fruits and other materials of low nutritive value in proportion to their bulk. Just as in the previous studies, it may have been simply the desire for variety which prompted the inmates to procure such extra food; nevertheless its existence must be considered in discussing the adequacy of the diet. But even making allowance for it, this study, like that in the aged men's home, suggests that persons in extreme age can be comfortably nourished on less protein than the 85 grams indicated by the standard.

COST AND SELECTION OF FOOD.

According to the report of the home for 1906, the cost of food materials for that year was $3,016.45, and the number of inmates and attendants about 70, making the average cost per person about 83 cents a week, or about 12 cents a day. The institution is to be congratulated upon its judicious expenditure; the cost was only about half as great as in the aged women's home and aged men's home, and this in spite of the fact that the German home received few gifts of food. The amount of nutrients provided was somewhat less, but the inmates seemed contented and well nourished. Unless one is to question the advisability of so low a protein supply, which would seem, however, entirely adequate for aged persons with little or no activity, criticism is useless in the face of so good a showing. Two or three peculiar features of the management may, however, be of interest to those having charge of similar dietaries.

The menus for the week showed that the suppers were very simple and lacking in variety, while the dinners were much more varied. This is said to be in accordance with a common German custom. No butter was served at noon except on Sunday. A peculiar system was in vogue as to vegetables; a larger quantity than was necessary for a single meal was cooked, and the surplus warmed over on the following day and served in smaller quantities. By following this custom two vegetables were obtained for each dinner, although but one had really been purchased for that meal. This permitted greater catering to individual tastes than would otherwise have been the case, and was appreciated by the inmates.

DIETARY STUDY NO. 689.

This study was made at the Maryland Home for Friendless Colored Children. During the year 1906 the institution received $1,065.40 from the city of Baltimore and $500 from the State of Maryland. There was a further very small income from board paid by a few children. Considerable dissatisfaction had been expressed by the city board of charities regarding the management of the home and radical changes had just been made to avoid the loss of the city appropriation. It had been very recently moved from a less desirable part of the city to its present location, and its policy had been altered. It had formerly received both boys and girls, but henceforth was to receive boys only. At the time of the study there were still 2 girls, who were to be removed as soon as desirable arrangements could be made, and 23 boys. The ages of the children ranged from 3 to 13 years. The care of the home and children was in the hands of a matron and two assistants, all colored. Definite information on some points was difficult to obtain, as the institution published no report.

The building was a well-located, three-story brick house, part of a city block, and large enough to accommodate from 20 to 30 children. There was a small yard in the rear. The dining room was a dark, back room only 12 feet square; into this were crowded two tables, seating, respectively, 12 and 13 children, a smaller one for the matron, and a refrigerator. The kitchen was immediately behind the dining room and contained few conveniences.

PURVEYING OF FOOD.

The institution depended for its food largely upon donations, which came in very irregularly. The staple food was stale bread, which was secured each day from local bakers. The materials which were bought were obtained rather at haphazard. Some foods were purchased in very small quantities—for instance, potatoes, on one occasion, were bought by the quart. On the other hand, a 200-pound bag of salt was found in the pantry, and both granulated and brown sugar were bought by the barrel, although very little of the granulated was used. Corned beef, bacon, hominy, and flour were also purchased in large quantities. There were considerable donations ot cake, cookies, pies, and occasionally fruit. It may be noted that the tea served at all the tables was very weak, 1 teaspoonful of leaves sufficing for a meal. Most of the 15 quarts of milk used during the week were mixed with the tea. In general, it may be said that no systematic attention was given to the food supply, although a weekly menu was found posted in the kitchen, presumably as a guide in serving meals.

KINDS OF DIET.

The matron and her assistants ate at the same time as the children, but had a much more varied diet, including considerably more meat, vegetables, and fruit. These items are separately listed in the table (p. 67) and include the greater part of the materials purchased. One of the children was ill with measles during the study and received a special diet for most of the week.

AGE, WEIGHT, AND PHYSICAL CONDITION OF CHILDREN.

The following table gives the statistics gathered on these points. The only scales available for weighing the children were in a penny-in-the-slot machine near by. Several rough tests of the accuracy of this were made which indicated that its readings were reasonably correct, and the weights here given are considered fairly reliable.

Ages and weights of negro orphans.

Subject.	Age.	Weight.	Subject.	Age.	Weight.
	Years.	*Pounds.*		*Years.*	*Pounds.*
Boy	3	39	Boy	10	56
Do	3	41	Do	10	58
Do	5	38	Do	10	75
Do	5	41	Do	10	76
Girl (probably tuberculous)	6	37	Do	10	78
Boy	7	48	Do	11	70
Girl	7	54	Do	11	74
Boy	8	45	Do	11	77
Do	9	54	Do	12	68
Do	9	56	Do	12	85
Do	9	56	Boy (only one leg)	13	68
Do	9	59			
Boy (probably tuberculous)	9	50	Average	8.7	58.6
Boy	9	62			

These figures seem slightly below the average for children of the respective ages, but the difference is not marked, especially in the older boys. The table of weights for different ages, as given by one of the large life insurance companies, is as follows:

Average weight of boys and girls at different ages, as shown by insurance statistics.

Subject.	Age.	Weight.	
		Boy.	Girl.
	Years.	*Pounds.*	*Pounds.*
Child	5	45	40
Do	6	50	43
Do	7	55	47
Do	8	57	52
Do	9	62	57
Do	10	67	62
Do	11	72	69
Do	12	78	78
Do	13	85	89

It should be said in this connection that probably the figures in the second table apply to children with more or heavier clothing. The orphans here studied went barefooted, and the clothing of the boys consisted simply of a shirt and pair of trousers. This would probably make a difference of at least 1 or 2 pounds in the weight.

In general, the children seemed in good health and spirits and showed little sign of underfeeding. Two, however, were in delicate health and seemed to the observer to be suffering from tuberculosis.

The following menu for one day, June 17, gives an idea of the kind of meals served.

MENU FOR WEDNESDAY, JUNE 17, 1906.

Breakfast: Bread, rolled oats, milk, brown sugar.
Dinner: Bread, corned beef, green peas, boiled cabbage.
Supper: Bread, molasses, brown sugar, cookies.

ATTENDANCE.

The study began with supper on June 14, after a preliminary observation of half a day, and continued through 21 meals. The total attendance for the week was 483 meals for boys, 42 for girls, and 62 for the matron and attendants. As has been pointed out, the diet at the matron's table was made up in part of that eaten by the children, but supplemented to a very large extent by additional materials. It is believed to be a fair assumption that the matron and her assistants ate the same amount of the regular diet as did the children and that the amounts of additional foods may be considered as compensating for the difference in age and activity. The girls were so young that it is not believed that their food consumption need be estimated separately from that of the boys. In other words, the entire attendance, 587 meals, equivalent to 1 child for 196 days, may be considered as the basis for computing the amounts "per child per day."

A means of verifying this assumption, however, is afforded by the supplementary list of foods eaten at the matron's table, as given at the end of the table on page 67. The nutrients in this, when divided by 3, the total number of women receiving these foods, and added to the amounts of protein and energy supplied per child per day give a total of 93.7 grams protein and 2,495 calories of energy, an ample ration for a woman at light to moderate muscular work.

Weight of total food and protein and fuel value of food per child per day, dietary study No. 689.

Kind and weight of food materials.	Amounts per child per day. Protein.	Fuel value.
ANIMAL FOOD.	*Grams.*	*Calories.*
Beef: Shoulder and clod, 5.13 pounds (6); corned, 10.38 pounds (12)	6.1	95
Pork: Backs, dry-salted, 5.63 pounds (27)	1.0	92
Fowl, 5 pounds (34)	2.2	27
Eggs, 2.81 pounds (41)	.8	9
Dairy products: Butter, 2.13 pounds (42); milk, 29.50 pounds (44)	2.3	88
Lard, 2.75 pounds (47)	....	59
Total animal food	12.4	370
VEGETABLE FOOD.		
Cereals: Hominy, 4.75 pounds (51), boiled, 3.13 pounds (52); oats, rolled, 4 pounds (53); rice, boiled, 3.75 pounds (56); wheat flour, 11.69 pounds (60); biscuit, Maryland, 10.56 pounds (67); bread, white, 124.94 pounds (66); rolls, 1.44 pounds (68); cake, baker's, 10.31 pounds (72), frosted, 1.13 pounds (73); pie, rhubarb, 2.25 pounds (74)	36.7	1,154
Sugar, etc.: Molasses, 7.88 pounds (77); sugar, brown, 11.56 pounds (78)	.4	156
Vegetables: Cabbage sprouts, 2 pounds (86); carrots, 0.63 pound (87); carrot tops, 2.19 pounds (88); onions, 0.38 pound (95); peas, green, 1.13 pounds (98); potatoes, 4.44 pounds (99); potatoes, boiled, 5.25 pounds (101); rhubarb, 3.63 pounds (102); squash, 7.06 pounds (106); tomatoes, canned, 2.13 pounds (111)	1.4	41
Total vegetable food	38.5	1,351
Total food	50.9	1,721
WASTE.		
Table and kitchen waste, 3.19 pounds (143)	.4	11
Soup, 15.25 pounds (136)	.3	33
Total waste	.7	44
Total food consumed	50.2	1,677
SPECIAL FOOD SERVED AT MATRON'S TABLE.		
Animal food: Beef, round, 4.69 pounds (4); lamb, leg, 2.50 pounds (16); pork, loin, 1 pound (21); pigs' feet, pickled, 1.38 pounds (28)	39.0	503
Vegetable food: Macaroni, 0.88 pound (63); rice, flaked, 0.19 pound (57); sugar, granulated, 1.69 pounds (79); cucumbers, 0.56 pound (90); leeks, 1.50 pounds (93); lettuce, 0.38 pound (94); tomatoes, 0.88 pound (107); bananas, 3.38 pounds (115); blackberries, 1.25 pounds (116)	4.5	315
Total special food per woman per day [a]	43.5	818
Total food per woman per day [a]	93.7	2,495

[a] See page 65.

WASTE.

The normal waste in this home was very small, amounting for the whole week to only 3 pounds 3 ounces. In fact, it proved easier to save and analyze all the waste than to sample it. The greater part, indeed, came from the matron's table; there was rarely anything but a few crumbs discarded by the children, and the kitchen waste consisted largely of the ends of loaves of bread.

Besides this usual waste, however, there were two losses due to negligence. The first was in the case of fresh cabbage, which was kept so long that the outer leaves had to be discarded. This was included with the regular waste. The second case was more notice-

able. About 35 pounds of chicken bones, from which most of the meat had been removed for salad, was donated by a caterer. A portion of this was given to the children immediately, but the remainder was made into soup and doled out gradually. Part of this was kept until it became unfit for food, and 15.4 pounds had to be thrown away. This of course involved a waste of the other materials in the soup as well as of the chicken itself. Even so, some soup was eaten after it had spoiled, and several of the children were made ill by it.

ADEQUACY OF THE DIET.

This topic will be discussed at length in a later section (see p. 87). Suffice it here to say that as compared with the dietary standard usually accepted in this country, the daily supply of protein, 50.2 grams, and the fuel value of the daily food, 1,677 calories, are both a trifle low. It may well be, however, that an investigation of the diet at another time would have found it more generous.

As was previously stated, most of the children had the appearance of fair health. They were always eager for more to eat, a boy on one occasion even eating the crumbs of table waste which had been gathered up after the meal, but such a state of things is too common among children generally to be of great significance. The children were forbidden to get food of any kind outside of the home, and it is not probable that they often obtained anything except a very little candy in this way. Judging from their rather low weights, they were none too well nourished. If we accept the general belief that an abundant diet, especially as regards protein, is necessary for the best development of a growing child, then the protein supply as shown by the period of the present study must be considered somewhat too low for the best results.

COST AND SELECTION OF FOOD.

No data are available as to the cost of this diet, but as it was practically all donated, the cash expenditure must have been very small. Since the orphans were fed so largely on whatever was available, discussion of its improvement seems futile. The question of the extent to which charitable institutions should solicit or even accept gifts of food, however, is a very broad one. After all, this home was merely an extreme type of what took place to a limited degree in all the Baltimore homes visited except the German Aged People's Home. Probably to a certain extent the system may be justified. So long, however, as people continue to give away what is of little value to themselves we should not expect foods of the best quality or suitability to be thus provided. An institution supplied with the equivalent in money would be able to expend its funds to much better advantage and in

addition be in a position to provide a systematic and well-ordered diet such as can not be obtained when the food supply is so largely the result of chance.

DIETARY STUDY NO. 690.

The last study of the series was made at the German Orphan Asylum (Allgemeines Deutsches Waisenhaus), a charitable institution in the northeastern part of Baltimore. It had a small endowment and receives $1,500 a year from the State, but was chiefly supported by the subscriptions of German-American residents of the city, from whom the board of management was also drawn. Although there were no restrictions as to the nationality of the orphans admitted, they were almost exclusively of German parentage. The immediate supervision of the asylum and children was in the hands of a superintendent and of his wife, who served as matron, and three teachers. A baker, a tailor, a shoemaker, and a cook, all Germans, were also employed, but the greater part of the housework was done by the older girls.

The neighborhood in which the asylum is located was a good one when the institution was established, about thirty years ago. It had recently, however, become very crowded and undesirable, and the management contemplated removing the asylum to the suburbs. The building was a large, detached four-story brick structure, with about an acre of playground in the rear. The house accommodated 165 children, and that number was enrolled at the time of the study, though about 40 of the youngest had been sent to a branch home in the country for the summer. The extensive storerooms and the bakery where the bread and pastry are made were in the basement. The general kitchen was a good-sized room on the first floor, and was equipped with a large modern range and many improved labor-saving devices. The main dining room, adjoining the kitchen, was a large, well-lighted room, with five long tables, seating from 11 to 36 children each. The tables and dining room floor were scrubbed after each meal. Meal hours for the children were 7.30 a. m., 12.15 p. m., and 6 p. m.

PURVEYING OF FOOD.

Particular attention was given in this institution to buying materials in bulk, and cereals, canned goods, apple butter, sirup, sugar, sauerkraut, potatoes, etc., were always obtained in that way. The food purchased was of good quality. The only dissatisfaction during the study was caused by the milk, which was obtained direct from a farmer; it did not keep well and was suspected to be of poor quality. The question was referred to an inspector of the city health department, who took samples for analysis. Besides the food purchased, the

asylum received frequent gifts of meats, bread, cake, vegetables, and fruit. There is no means of knowing how large a proportion of the diet during the study was obtained in this way. Shrewd management and good business judgment were everywhere manifested in this home, as were also neatness and thrift.

KINDS OF DIET.

Four different diets were served during this study: (1) The superintendent's private table, at which meals were served to all the adults and the superintendent's two children immediately before the orphans were served. Special meats and vegetables were always provided for this table, though not necessarily more expensive kinds. The other foods were mainly of the same kind as those for the regular table. Articles used exclusively for this table are so designated in the table (p. 73). (2) Working girls' table, for the 11 oldest girls, who had regular household duties. Their fare consisted of the regular diet, supplemented at dinner by coffee, with milk and sugar, and at supper by fried potatoes and some kind of meat, usually cold. (3) Table for children under 8 years old, of whom there were only six at the time of the study. They had the regular diet, with milk at each meal, and no tea or coffee. (4) Regular table for all other children. A sample menu of this group for the week studied is given on page 71.

AGE, WEIGHT, AND PHYSICAL CONDITION OF CHILDREN.

The statistics regarding the age and weight of the boys and girls in the asylum are shown in the following table:

Age and weight of children, dietary study No. 690.

Age of children.[a]	Number of boys.	Average weight of boys.	Number of girls.	Average weight of girls.
Years.		*Pounds.*		*Pounds.*
4	1	31.0		
5	1	37.0		
6				
7	1	43.0	3	42.7
8	3	48.0	2	54.5
9	3	49.3	9	51.9
10	6	51.5	6	52.7
11	8	51.9	7	61.0
12	10	61.4	3	64.7
13	17	64.4	6	74.3
14	7	70.3	4	93.7
15	1	107.0	6	99.7
16			7	105.6
17			4	109.5
Total	58		57	
Average		59.2		74.3

[a] Average age: Boys, 11.5; girls, 12.2 years.

Comparison with the figures published by one of the large life insurance companies and with the weights of negro children in the

preceding study (see p. 65) shows that while these children weighed a little more than the negro orphans their weights were considerably lower than those given by the insurance company. It should be remembered that these studies were made in June, in a warm climate, and the clothing worn would probably weigh considerably less than that of the average child under other circumstances. Low weights were more noticeable among the boys than the girls, and especially among the older boys. The observer was surprised to learn the ages of the larger boys, as he had supposed them well-developed boys several years younger than they actually were. The low weight among those over 12 years of age may be partly explained by the fact that after reaching that age the boys were frequently apprenticed, and those remaining in the asylum would represent the least robust. In general, the children appeared in excellent health, and the institution had an unusually good record in this respect. During the week of the study there was but one case of sickness among 120 children, and in the fifteen years in which the superintendent had been in charge there had been but three deaths in the asylum.

The following menu for one day is given as a sample of the diet served at the regular table during the study:

MENU FOR JUNE 23, 1906.

Breakfast: Bread, with apple butter, coffee, and rolled oats with milk and sugar.

Dinner: Bread, rice boiled, potatoes boiled, prunes stewed.

Supper: Bologna sausage, bread, tea with milk and sugar.

ATTENDANCE.

On account of the necessity of completing the study before June 30, the end of the fiscal year, the preliminary period of observation was omitted. The study began with dinner on June 22 and was continued through 21 meals. The number of meals served during this time was: To men, 89; to women, 121; to girls, 1,181; to boys, 1,208, a total of 210 to adults and 2,389 to children.

The computation of the amounts eaten per person per day in this study is somewhat complex, as the population included adults and children of both sexes and of various ages and duties. The men, namely, a superintendent, baker, tailor, and shoemaker, all assisted in looking after the boys at various times, in addition to their other duties. The women were the matron, the aged mother of the superintendent, the cook, and three teachers. The older boys were being taught baking, tailoring, and shoe repairing in the home, and the older girls were quite actively engaged in the kitchen and laundry. The younger children attended school when in session, but at the time the study was made it was vacation and they had no regular

duties. Further, as has been already explained, four different diets were served regularly (see p. 70).

Two special difficulties were also encountered. The first was the absence of 74 children and 2 teachers from dinner on the sixth day of the study, because of a picnic. A lunch of sandwiches of cheese and cold ham and beef, and rolls, was prepared at the home and taken along; hence it could not be assumed that the picnickers were absent from any meals. Many of them, however, bought, in addition to this lunch, peanuts, popcorn, ice cream, etc., in unknown amounts, so that while the sandwiches could not have been equivalent to the dinner usually served, the appetites of these children were noticed to be very small at supper and much less than the usual amount of food was eaten at that time.

The second difficulty was encountered on the day following, which was the monthly visiting day. On this occasion it is the custom for relatives and friends to bring to the individual children fancy cookies, cake, fruit, etc., and the total amount thus brought in was quite considerable. In the opinion of the observer each child must have had at least the equivalent of one banana and one cookie, although owing to the varied character of the gifts the exact kind and amount could not be ascertained. It seems, however, safe to assume that this error and the one due to the picnic together make the equivalent of perhaps one meal for each child, but it was not deemed wise to regard this in the calculations. In view of all the sources of uncertainty, the accuracy of this study is probably not so great as that of the others, and this must be kept in mind in drawing deductions from the work.

An attempt has been made to make the calculations in two ways, so that each may act as a check on the other. To obtain the figures given in the table on page 73 it was assumed that the food consumption of the adults was 1.5 that of the children; the number of meals for adults, 210, was multiplied by 1.5, making 315, which, added to those for children, 2,389, gives a total of 2,704, equivalent to 1 child for 901 days. This method assumes that the adults were at light to moderate muscular work, and that the children were from 10 to 12 years of age.[a] While the figures are not absolutely accurate, the error introduced can not be large.

As a check to these calculations the total amount of protein and energy consumed during the entire week by the whole population (58,700 grams of protein and 1,620,700 calories of energy) was taken and from this were deducted the amounts eaten by the adults, assuming that each man consumed 112 grams protein and 3,050 calories of energy, and each woman 90 grams protein and 2,450 calories of energy per day.[b] As there were 89 meals for men, or 1

[a] U. S. Dept. Agr., Farmers' Bul. 142, p. 33.
[b] U. S. Dept. Agr., Farmers' Bul. 142, p. 35.

man for thirty days, and 121 for women, or 1 woman for forty days, these amounts are 3,360 grams protein and 91,500 calories of energy, plus 3,600 grams protein and 98,000 calories of energy, or a total of 6,960 grams protein and 189,500 calories of energy. The results obtained after this subtraction were divided by 796 (or 2,389÷3), which is the equivalent number of food days for 1 child. This second calculation gives the amounts consumed per child per day as 65 grams of protein and 1,798 calories of energy, practically identical with the 65.1 grams of protein and 1,798 calories of energy obtained by the first method.

Weight of total food, and protein and fuel value of food per child per day, dietary study No. 690.

Kind and weight of food materials.	Amounts per child per day.	
	Protein.	Fuel value.
ANIMAL FOOD.		
Beef: Ribs, 22.50 pounds (2); roast,[a] 0.69 pound (9); rump,[a] 12.19 pounds (5); shoulder and clod, 45.75 pounds (6); steak, Hamburg,[a] 9.63 pounds (11)	*Grams.* 8.8	*Calories.* 119
Veal, leg, 27.69 pounds (14)	2.9	21
Mutton, leg, 10 pounds (17)	.9	12
Pork: Rib, 30 pounds (19); side, cooked,[a] 0.56 pound (22); ham, smoked, salted, and boiled, 18.88 pounds (24)	4.6	83
Sausage: Bologna, 20 pounds (30); liver, 15.56 pounds (32)	2.8	47
Eggs, 15.13 pounds (41)	.9	11
Dairy products: Butter, 7 pounds (42); cheese, full cream, 10.38 pounds (43); milk, 650.63 pounds (44)	12.2	285
Lard, 15.44 pounds (47)	....	72
Total animal food	33.1	650
VEGETABLE FOOD.		
Cereals: Barley, pearled, 9.25 pounds (49); oats, rolled, 31.50 pounds (53); rice, 15 pounds (55); wheat flour, 299.56 pounds (60); bread, wheat, 139 pounds (66); bread, wheat and rye, 16.25 pounds (69); cake, bakers',[a] 1 pound (72)	27.3	868
Sugars: Brown, 30.50 pounds (78); granulated, 39.56 pounds (7)	....	141
Vegetables: Beans, string,[a] 2.56 pounds (82); beets,[a] 3.63 pounds (83); cabbage, 41.88 pounds (84); cabbage, boiled, 7.56 pounds (85); cucumbers,[a] 3.13 pounds (89); kohl-rabi,[a] 3.88 pounds (92); lettuce,[a] 3.25 pounds (94); onions,[a] 1.19 pounds (96); peas, dried, 20.50 pounds (97); potatoes, 126.69 pounds (99); rhubarb,[a] 2.25 pounds (101); sauerkraut, 14.06 pounds (104); beans, baked and canned, 50.25 pounds (108); beans, string, pickled, 17.25 pounds (112)	6.5	140
Fruit: Lemons,[a] 1.75 pounds (117); pineapple,[a] 8.25 pounds (119); prunes, 10.31 pounds (123); peaches, canned, 6.13 pounds (126); jelly, currant, 13.38 pounds (130)	.2	36
Apple butter, 19.94 pounds (133)	.1	11
Beer,[a] 11 pounds (134)	....	11
Olive oil,[a] 2.38 pounds (135)	....	3
Total vegetable food	34.1	1,210
Total food	67.2	1,860
FOOD UNCONSUMED.		
Food unused at end of study: Beef, rump, cooked, 1.50 pounds (10); fat, 1 pound (46); beets, pickled, 1 pound (113)	.2	7
Waste, 104.44 pounds (144)	1.9	55
Total food unconsumed	2.1	62
Total food consumed	65.1	1,798

[a] Served only at superintendent's table.

WASTE.

The total amount of food wasted in this study was 104 pounds 7 ounces, containing about 3 per cent of the total protein and energy of the food. This proportion is very small, especially when it is remembered that the subjects were children, and it is well known that children often show a tendency to leave food uneaten. In the present study this rarely occurred. This may be partly explained by the rule requiring them to eat whatever they took on their plates, but the observer noticed furthermore that very little food was returned from the dining room to the kitchen from the large dishes in which it was served, or, in other words, that the total amount served at each table was consumed. Exceedingly good judgment as to the amount likely to be eaten probably explains this. Moreover, the fact that on the evening of the picnic and visiting days, when the appetite had been satisfied by extra food, food was left both on the serving and individual plates affords a strong corroboration of the supposition.

All waste from the plates was thrown away as garbage. When surplus meats and similar materials remained in the serving dishes, they were utilized at the table of the larger girls. In general, efforts to reduce waste of every sort were manifest.

ADEQUACY OF THE DIET.

In spite of the discrepancies discussed above, the amounts per child per day given in the table (p. 73) are probably sufficiently correct to be used as a general basis of discussion, which will be given beyond (see p. 87).

It may be briefly stated here that the protein and energy of the diet were about equal to those suggested by the commonly accepted standard for boys of 11 and girls of 12 years of age, whereas the children's ages averaged a few months higher. When we consider that on the average they were under normal weight, it becomes a question whether a slightly more liberal diet would not be desirable. At the same time it must be admitted that the children appeared healthy and comfortable on the food supplied.

COST AND SELECTION OF FOOD.

The report of the asylum for the year 1906 gives the cost of food as $4,462.59 and the number of children as 153, indicating an average cost of 56 cents per child per week, or 8 cents a day. Many of the materials used were donated, especially the more expensive kinds, so that these figures do not represent the actual cost of the total food used. It is impossible to say how much should be added for the donations, but it must certainly be a noticeable amount. Even making due allowance for this, there is every reason to believe that the

money spent for food was not at all excessive and brought a good return to the institution.

As in the German Aged People's Home, the breakfasts and suppers were very plain and monotonous, and the dinners much more varied, and this arrangement, while not in accord with the usual custom in this country, seemed acceptable to the inmates and is said to be in accord with German custom. Aside from this point, the diet in this asylum had no striking features and seemed chosen with economy and wisdom.

THE DIETARY STUDIES WITH THE AGED AND THEIR RESULTS.

DIETARY REQUIREMENTS OF THE AGED.

Temperament and other factors undoubtedly have an effect upon the amounts of food consumed by individuals, but, considering average values and uniform body weight, it is generally conceded that the most important factors in determining food requirements are age, sex, and muscular activity. The commonly accepted American dietary standards assume that a woman requires eight-tenths as much protein and energy as a man performing a like amount of muscular work of the same degree of intensity; that children require smaller quantities than adults; that their requirements increase until they are fully grown; and, in general, that food requirements are directly dependent upon the amount of muscular work performed. Data regarding the effects of age have been limited, and the standards referred to have not given factors for middle life and old age, though it is generally recognized that after man has reached maturity and the development of his powers there is a natural physical decline, and many writers on dietetics have insisted that there is a corresponding decline in food requirements.

The literature regarding the relations of old age to tissue metabolism, cell activity, and related topics is fairly large, but no attempt is made to review it thoroughly here. Some of the more interesting studies, however, will be briefly referred to in the following paragraphs and their results given in the table on page 83.

Cornaro, an Italian who published a treatise on the subject in the sixteenth century, is often cited as an example of the advantages to be derived from a diet simple in character and restricted in amount. According to his own statement,[a] when 35 to 40 years of age, he became very ill as a result of excesses of all kinds and was advised by his physicians to change his habits and to observe great moderation in food, drink, and all things. After more or less experimenting with foods and drinks to ascertain whether those which pleased the palate

[a] A Treatise of Temperance and Sobrietie. Translated by G. Herbert. [First Italian edition appeared in 1558.]

also agreed with him, he gave up his former excesses and regained his health, living a regular life for many years. He paid great attention to exercise in the open air, to sleep, to wholesome pleasures, and all other things which make for health as much as does diet. In his first essay, written when he was 83 years old, he gives some details regarding his food habits, stating that when 78 or 79 his daily fare consisted of 12 ounces of bread, egg yolk, broth and meat, and 12 ounces of wine. Whether these amounts are the same as he consumed when younger is not stated. However, in one of his essays he says that as he advanced in years and lost strength he felt that he should lessen rather than increase the quantity of food eaten, so it is not improbable that his diet in the years immediately following the change in his manner of living was more generous than in old age. In speaking of the foods which he used when 86 years of age, Cornaro mentions veal, kid, mutton, eggs, bread, porridge, broth, chicken and other poultry, wild birds, and fish, but there is nothing said of the amounts eaten. The fact is so clearly recognized by Cornaro that food requirements diminish as a person grows old that it seems fair to conclude that he modified his diet in accordance with this view and that his experience may be regarded as an excellent illustration of the advantage of great moderation in advancing years.

Lessius,[a] a writer on dietetics of a little later date than Cornaro, expresses very similar views regarding food requirements in later life. He states clearly that labor very largely determines the food requirements for persons of like age, and that old persons require smaller amounts than the young or middle aged. In his opinion, the diet of the aged should consist of bread, meat, eggs, and such foods, the total daily quantity ranging from 12 to 14 ounces. Other early writers could be cited in support of this belief.

Most of the recent writers, including such authorities as Voit,[b] Munk and Ewald,[c] and Sir Henry Thompson,[d] may be cited in support of the theory that those who have passed middle life do not require as much food as the young.

Sir Henry Thompson sums up the matter thus:

> As we increase in age—when we have spent, say, our first half century—less energy and activity remain, and less expenditure can be made; less power to eliminate is possible at 50 than at 30, still less at 60 and upward. Less nutriment, therefore, must be taken in proportion as age advances, or rather as activity diminishes, or the individual will suffer. If he continues to consume

---

[a] Hygrasticon, or the Right Course of Preserving Life and Health unto Extreme Old Age. Cambridge, 1634.

[b] Ztschr. Biol., 12 (1876), p. 32.

[c] Ernährung des gesunden und kranken Menschen. Vienna and Leipsic, 1895, pp. 72, 214.

[d] Diet in Relation to Age and Activity. London and New York, 1902.

the same abundant breakfasts, substantial lunches, and heavy dinners, which at the summit of his power he could dispose of almost with impunity, he will in time certainly either accumulate fat or become acquainted with gout or rheumatism, or show signs of unhealthy deposit of some kind in some part of the body * * * which must inevitably empoison, undermine, or shorten his remaining term of life. He must reduce his "intake," because a smaller expenditure is an enforced condition of existence. At 70 the man's power has further diminished and the nutriment must correspond thereto, if he desires still another term of comfortable life. And why should he not? Then at 80, with less activity, there must be still less "support."

Moderation is the keynote of the advice which he gives regarding diet suited to middle life and old age.

The great practical rule of life in regard to human diet will not be found in enforcing limitation of the sources of food which nature has abundantly provided. On the contrary, that rule is fulfilled in perfect development of the art of adapting food of any and every kind to the needs of the body according to the very varied circumstances of the individual, at different ages, with different forms of activity, with different inherent personal peculiarities, and with different environments.

He conformed his own habits to his beliefs regarding moderation in diet and in all things, and lived to be over 80 years of age. Special attention was paid to moderate exercise in the open air and to other matters of hygiene. He advises a dietary system which he states can be varied according to the idiosyncrasies of the individual. This includes four small meals per day, namely, breakfast about 8.30, luncheon at about 1, dinner at 7, and a light supper at about 11. The animal food recommended for breakfast and luncheon includes egg or fish. A little meat or fowl may be taken at luncheon, unless it is preferred to reserve them for dinner, in which case fish and a farinaceous pudding may be substituted. The dinner he recommends includes a little consommé, purée of fish or soup, and a little fowl or game, with a dish of vegetables, and finally some light farinaceous pudding with or without fruit. The supper late in the evening, which is considered to promote sleep, consists of 4 or 5 ounces of consommé with an ounce of thin toasted bread. For all meals the bread, whether whole wheat or white, in the opinion of the writer cited, should be thoroughly toasted, a quantity weighing 3 to 5 ounces before toasting being sufficient for a meal. Butter also forms a part of the meals, 3 or 4 ounces being thought desirable daily, including that which is used in the cooking. Weak tea or coffee with milk and aerated distilled water are recommended as beverages.

It is perhaps hardly fair to estimate the quantities of nutrients furnished by this diet, as few of the quantities are definitely stated. However, such calculations have been made on the basis of what is believed to be an average menu of the character suggested and the

average amounts of the different foods which would be served ordinarily.

The quantities assumed per man per day were 2 eggs, 4 ounces; toast, 3 ounces; fowl, 3 ounces; vegetable soup, 6 ounces; tenderloin steak, 3 ounces; rice pudding, 6 ounces; oranges, 5 ounces; consommé, 6 ounces; vegetables (as potatoes), 5 ounces; bread, 9 ounces; butter, 3.5 ounces; sugar, 1.5 ounces; and milk, 4 ounces. On the basis of average values for composition this daily ration would supply 103 grams protein and 1,820 calories of energy. This is practically the amount of protein, but considerably less energy than is called for by the standard proposed by Voit for old men.

Diet in old age is discussed by H. Campbell in a recently published volume,[a] edited by G. A. Sutherland, dealing with diet and dietetics in health and disease. The most suitable diet for the aged, it is pointed out, is that—

> which constitutes the ideal diet for man in general. Such a dietary demands (*a*) moderation in quantity, (*b*) simplicity in quality, and (*c*) the avoidance of those starchy foods which are apt to slip into the stomach without having been first adequately insalivated * * *.
>
> By a simple diet is meant one consisting of such items as bread, plain biscuits, plain puddings, plainly cooked vegetables, fruit, meat, bird, fish (all plainly cooked), milk, butter, cheese (such as Cheddar), tea, coffee, cocoa, salt.

Doctor Campbell has devoted a great deal of attention to the study of the evolution of the diet of man, and in his discussion of diet for the aged considers the subject to some extent from this standpoint.

> It is worthy of note that the diet of early man conformed to these three requirements. It was simple, consisting as it did of unprepared animal and vegetable substances; the quantity was not on the whole in excess of physiological needs; and all the starchy food being raw, it had to be abundantly masticated in order to break up the nondigestible cellulose framework and thus liberate the contained foodstuffs.

The three important food functions from a dietetic standpoint, as the author points out, are "digestion (i. e., the conversion of the ingested food into nutrient plasma), metabolism (i. e., the nutritive changes which the absorbed food undergoes in the tissues), and excretion (i. e., the removal of waste products).

> These three functions, as we may term them, are most vigorous in youth and early adult life. Then it is that digestion is most vigorous, metabolism most active, and excretion most efficient. At 40, or thereabouts, the digestive function often begins to show signs of failure, and greater care has to be exercised in the selection of food than was before necessary. Apart from this there is now a greater disposition to prudence—the recklessness of youth tends to depart with maturer years * * *. This dietetic imprudence may survive childhood, adolescence, early adult life, nay, it may persist into old age, but most people have acquired some sort of dietetic wisdom by the time they have reached middle age.

---

[a] A System of Diet and Dietetics. London, 1908, pp. 731–740.

At this period not only does digestion often begin to lose its former vigor, but metabolism also shows signs of flagging * * *.

Except in the case of definite disease of the excretory organs, it is doubtful whether the aged suffer in any marked degree from their inefficiency.

Regarding the dietetic instincts of the aged, some general statements are made, from which the following are quoted:

Though doubtless the appetite for plain food tends to lose its keen edge with advancing years, and the dietetic instinct—the liking for different kinds of food—to alter somewhat, the changes in these respects are often less marked than might perhaps have been expected.

The appetite for plain food may last to extreme old age. We have found from inquiry at several workhouses that the aged inmates have, for the most part, right good appetites for the simple fare provided, and that their dietetic instincts are much the same as those of their younger companions * * *.

Perhaps the most notable change which the dietetic instinct undergoes with advancing years is expressed by the gradual curtailment of starchy and sugary food during early and middle adult life. Most children are very fond of sugar and cakes, but this liking often suffers a marked diminution when adult life is reached. This is more noticeable in the man than in the woman * * *. After middle life the saccharids are often still further cut down: The "sweet" becomes the least welcome part of the meal and is frequently passed by.

With respect to the capacity of the organism to cope with different kinds of food, the influence of custom and idiosyncrasy, as well as old age, must be reckoned with, as Doctor Campbell points out.

As to the first of these influences, while one should be cautious in recommending to an aged person a diet very different from that to which he has for many years been accustomed, the experience derived from prisons, workhouses, and similar institutions shows that the ability of the aged to adapt themselves to novel kinds of diet is by no means small. * * *

The factor of idiosyncrasy is an important one. Individuals differ greatly, quite irrespective of age, in their digestive and metabolic capacities. We meet with children who are unable to tolerate foods which old people can digest quite easily, and, again, with others who are made ill by even a slight excess, while their grandparents can perhaps consume a large excess with comparative impunity. Some old people have, in fact, prodigious powers of digestion and metabolism. * * * Most of these remarkable old people would doubtless enjoy better health * * * on a more abstemious diet; nevertheless, in regulating their food we must make due allowance for their prodigious powers * * *.

Making due allowance, however, for the personal element, our rule obtains that while all should endeavor to conform as far as possible to the ideal dietary, allowing themselves no more than an occasional excess, it becomes with advancing years increasingly necessary for the majority of people to eat moderately of simple foods, and not to swallow starchy foods without having first insalivated them thoroughly. If we add to these rules the further ones that old people should take full advantage of dental surgery, that in the case of the toothless certain of the tougher varieties of food should be broken up mechanically before being taken, and finally that due regard should be had to the influence of idiosyncrasy and habit, we have said all that is worth saying concerning the diet of the aged.

The dietary for men from 60 years of age at one of the large London workhouses, according to Doctor Campbell,[a] consists of 20 ounces bread, 1 ounce oleomargarine, 1 ounce sugar, 4 ounces meat, 8 ounces potatoes, and 4 ounces green vegetables per day, with pudding once a week and stewed fruit twice a week. Salt and pepper are allowed daily and mustard once a week. Each person is allowed 2 pints of tea a day. The bread, it is stated, is baked from grain ground on the premises. Most of it is made from so-called "whole meal," but a small portion consists of 2 parts of white flour and 1 part of whole meal.

For purposes of comparison with the other data included in this bulletin, the nutritive value of this dietary has been calculated by means of average figures, and, as shown by data in the table on page 84, supplies 79 grams protein and 2,340 calories per man per day.

Concerning this diet Doctor Campbell makes the following statements:

> It must be admitted that this is an ample allowance, probably in excess of actual requirements. Nevertheless, most of the inmates, even the very old ones, consume the whole of their portion and appear to enjoy it thoroughly. The toothless among them seem to manage quite well; the bread crusts they soak in their tea, and the meat is generally, though by no means in every case, minced for them.
>
> It is noteworthy that these old people complain very little of indigestion, and—what is even more surprising—suffer little from constipation. Thus in one large workhouse each inmate gets on an average no more than three doses of aperient in the year. Doubtless this comparative absence of indigestion and constipation is to be explained by the simplicity and good quality of the food provided, by the clock-like regularity of the daily routine, and by the high hygienic standard prevailing in the workhouse.

Of special studies with aged persons the following seem particularly interesting:

In connection with an extended series of studies on respiration and metabolism, carried on by Sonden and Tigerstedt[b] with a respiration apparatus of special construction, young, middle-aged, and old subjects were included. The data recorded show that with both men and women the amount of carbon dioxid excreted per square meter of surface area is greater with young than with older persons, which it is believed is a proof that, independent of its smaller size, the young organism possesses a more active metabolism than the older one. In youth the carbon dioxid excreted per kilogram of body weight and per square meter of surface area is greater with males than with females. This difference gradually diminishes, and in old age there is no difference in the sexes in this respect.

---

[a] A System of Diet and Dietetics. London, 1908, pp. 731–740.

[b] Skand. Arch. Physiol., 6 (1895), p. 1.

Kovesi[a] found, in studies with women aged, respectively, 76 and 78 years, that it was possible to attain nitrogen equilibrium with 10.6 to 12.3 grams of nitrogen per day, and that in extreme old age the energy requirements of the body were lowered, 20 calories per day per kilogram body weight being, in his opinion, the lowest limit. The conclusion was also reached that cell metabolism is less active in old age than in youth and that this accounts for the diminished proteid requirement which was observed and which is considered characteristic of old age.

From his experiments with old women, von Limbeck[b] concluded that the digestibility of protein and fat was normal and that, in general, the proportion of the different nitrogenous constituents of the urine was practically normal with the exception of ammonia. Notwithstanding the low energy value of the diet, both his subjects gained in weight and excreted less nitrogen than was consumed. In other words, the nutrients and energy supplied by the food seemed amply sufficient for the body needs.

A woman whose dietary was studied by Fenger[c] was 61 years old at the beginning of the experimental period and was under observation at intervals for fifteen years. From choice her diet was very simple, consisting of such foods as eggs, oatmeal, soup, skim milk, fruit, and a little wine. On this simple diet the subject remained in good health and seemed normal as regards the assimilation of nitrogen. No tests were made of the effects of diets of different character. Fenger considers it fair to conclude that a diet may be considered suitable for the old which contains protein enough to supply body demands and maintain health through long periods, requirements which were evidently met by the diet selected by the subject of his experiments.

Interesting and valuable as these and other similar investigations undoubtedly are, it is evident that they do not furnish so broad a basis for dietary standards as do the much more numerous studies of persons in full vigor. The standards most commonly accepted for the aged are those of Voit, who bases them mainly on the work of Forster. They indicate a ration with about 0.8 of the nutritive value of those indicated for men or women in full vigor and at moderate muscular work; in other words, from 90 to 100 grams of protein and from about 2,100 to about 2,900 calories of energy per man per day, or from 80 to 100 grams of protein and from 2,100 to 2,900 calories of energy per woman per day, the amounts to be varied according to the muscular work performed.

---

[a] Centbl. Inn. Med., 22 (1901), p. 121.
[b] Ztschr. Klin. Med., 26 (1894), p. 437.
[c] Skand. Arch. Physiol., 16 (1904), p. 222.

One of the most thorough attempts to determine exactly the amount of nutrients necessary for the maintenance of the body at different ages is that of Maurel.[a] He estimates from his own clinical and experimental observations and those of others that to maintain the body in equilibrium when no external muscular work is performed the adult in full vigor, either man or woman, requires 1.5 grams of protein and from 35 to 38 calories of energy per kilogram of body weight, any muscular exertion being met by an increased supply of nutrients. Thus, for a man weighing 70 kilograms (154 pounds), the daily maintenance ration, according to Maurel, should contain 105 grams of protein and from 2,450 to 2,660 calories of energy, or for a woman weighing 60 kilograms (132 pounds), 90 grams of protein and from 2,100 to 2,280 calories of energy. For persons in the first period of physical decline (from 50 to 70 years), he considers that the protein may be reduced to 1.25 grams and the energy to from 30 to 35 calories per kilogram of body weight. In the second period of old age (from 70 years on), he believes that the nutritive demands fall off yet more until, in extreme age, 0.75 grams of protein and from 20 to 25 calories of energy per kilogram of body weight are ample to maintain the body in equilibrium. Of course, as age increases, general muscular exertion usually decreases also, so that the maintenance ration just quoted approaches the total requirement much more nearly than do those given for persons in full vigor, even where the latter perform little external muscular work. It should also be noted that body weight usually decreases rapidly in old age, even among people whose food is abundant, and hence, if we estimate nutritive requirements per kilogram of body weight, they decrease correspondingly.

If we take the average weight of persons in old age as given by Quetelet[b] and apply to them the maximum factors suggested by Maurel we find the maintenance ration to be as given in the following table:

Estimated food requirements of aged men and women based on Maurel and Quetelet figures.

Subjects.	Age.	Average weight.		Protein required.	Energy required.
	Years.	*Kilograms.*	*Pounds.*	*Grams.*	*Calories.*
Men	60	65.50	144.1	81.9	1,965
Do	70	63.03	138.7	78.8	1,891
Do	80	61.22	134.7	45.9	1,531
Do	90	57.83	117.2	43.4	1,446
Women	60	56.73	124.8	70.9	1,702
Do	70	53.72	118.2	67.2	1,612
Do	80	51.52	113.3	38.6	1,288
Do	90	49.34	108.5	37.0	1,234

[a] Rev. Soc. Sci. Hyg. Aliment., 3 (1906), p. 763.
[b] Landois and Sterling: Text-book of Human Physiology, London, 1891.

While Maurel's factors give for adults in full vigor a ration hardly below that commonly accepted, his standards for the aged are lower than those usually applied. Since, however, he takes into account the decrease of body weight as well as of activity, it may be that they represent more nearly the minimum ration which may safely be applied. However, they represent a maintenance ration merely, and any external muscular work must be met by an increased ration.

FOOD IN BALTIMORE AND PHILADELPHIA HOMES FOR THE AGED COMPARED WITH OTHER INSTITUTIONS AND STANDARDS.

A summary of the results of the dietary studies in Baltimore and Philadelphia is given in the following table, which also includes for purposes of comparison the results of a number of dietary studies made elsewhere in public institutions, as well as data from the investigations and the standards referred to in the preceding section.

Summary of studies in public institutions and studies with, and standards for, aged persons.

Study No.	Location and subjects of studies.	Number of persons in study.	Nutrients and energy.					
			In food eaten.		In food wasted.		Proportion in food wasted.	
			Protein.	Energy.	Protein.	Energy.	Protein.	Energy.
	STUDIES IN INSTITUTIONS.							
	Bayview, Baltimore:		*Grams.*	*Calories.*	*Grams.*	*Calories.*	*Per cent.*	*Per cent.*
682	Regular inmates, males	136	144	2,901	4	97	3	3
683	Chronic inmates, males	82	93	2,076	2	45	2	2
685	Receiving-ward inmates, males	82	111	2,274	1	11	1	....
	Average of 3 studies	....	121	2,504	3	59	2	2
684	Women inmates, per woman per day	111	85	1,924	6	134	7	7
684	Women inmates, per man per day basis	111	106	2,405	8	168	7	7
	Average of 4 studies	411	117	2,453	4	89	3	3
	Entire institution [a]	....	96	2,398	....	....	....	....
686	Aged women's home, Baltimore, per woman per day	....	85	2,206	12	308	14	14
687	Aged men's home, Baltimore, per man per day	....	83	2,339	9	304	11	13
688	German Aged People's Home, Baltimore, per man per day	....	74	2,225	8	265	11	12
691	Old Ladies' Home, Philadelphia, per woman per day	....	58	1,882	....	....	8	8
	Government Hospital for the Insane, male patients: [b]							
	Middle to old age, largely chronic, orderly, quiet, few workers, average of 10 studies	952	88	2,767	13	341	13	11
	Acute, nervous, disturbed, nonworkers, average of 3 studies	94	84	2,599	22	567	21	18
	Negroes, whole group	169	98	2,536	12	315	11	11
	Negroes, nonworkers	89	90	2,402	12	306	12	11
	Negroes, workers	80	108	2,694	13	319	11	11
	Sick, infirm, and bedridden, average of 2 studies	166	97	2,519	34	802	26	24
	Younger and more active class, some curable, part workers, average of 2 studies	59	104	2,917	12	256	10	8

[a] Calculated from food purchased (see p. 36).
[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 150.

***Summary of studies in public institutions and studies with, and standards for, aged persons*—Continued.**

Study No.	Location and subjects of studies.	Number of persons in study.	Nutrients and energy.					
			In food eaten.		In food wasted.		Proportion in food wasted.	
			Protein.	Energy.	Protein.	Energy.	Protein.	Energy
	STUDIES IN INSTITUTIONS—con.							
	Government Hospital for the Insane, male patients—Con.							
	Better class, on first section diet, average of 2 studies	22	*Grams.* 125	*Calories.* 3,398	*Grams.* 29	*Calories.* 753	*Per cent.* 19	*Per cent.* 18
	Unclassified, average of 2 studies	127	76	2,609	18	539	19	17
	Unclassified, average of all patients	....	90	2,704	16	415	15	13
	New York state hospitals for the insane, male patients:							
	Chronic, infirm, average of 8 studies	1,069	72	2,259	4	90	5	4
	Light workers and disturbed, average of 2 studies	318	73	2,255	4	94	5	4
	Restless, active, disturbed, average of 2 studies	258	95	2,665	6	142	6	5
	Workers, average of 10 studies	1,595	105	2,908	7	132	7	4
	Acute, recent admission, average of 2 studies	70	65	2,477	7	161	9	6
	Acute and sick, chronic, average of 2 studies	35	66	2,432	4	94	6	4
	Almshouse, Baltimore, 1852:[a]							
	Nonworkers	....	78	1,959	....	....	....	....
	Workers	....	85	2,057	....	....	....	....
	Long Island almshouse and hospital, Boston[b]	....	109	3,164	....	....	....	....
	Charlestown almshouse and hospital, Boston[b]	....	71	2,415	....	....	....	....
	Scotch poorhouse:[c]							
	Adults, both sexes, just admitted, no work	....	84	1,870	....	....	....	....
	Adults, both sexes, regular inmates, no work	....	86	2,030	....	....	....	....
	Adults both sexes, regular inmates, work	....	112	2,380	....	....	....	....
	Scotch Almshouse for Pauper Lunatics:[d]							
	Excessive dietaries, males, average of 11 studies	....	149	3,789	....	....	....	....
	Dietaries approximating standards, females, average of 13 studies	....	136	3,340	....	....	....	....
	Deficient dietaries, males, average of 15 studies	....	119	2,908	....	....	....	....
	Excessive dietaries females, average of 25 studies	....	119	3,057	....	....	....	....
	Dietaries approximating standards, females, average of 8 studies	....	108	2,695	....	....	....	....
	Deficient dietaries, females, average of 6 studies	....	95	2,488	....	....	....	....
	Home for Old Men, Munich[e]	....	92	2,155	....	....	....	....
	Home for Old Women, Munich[e]	....	80	1,875	....	....	....	....
	Old men (over 60 years) workhouse, London[f]	....	70	2,340	....	....	....	....

[a] Calculated from data given by Gould; Report on Food and Diet Suited for Almshouses, Prisons, and Hospitals. New York, 1852, p. 79.

[b] Ellen H. Richards and Sarah E. Wentworth; Second Report of Institutions Commissioner. Boston, 1897, p. 206.

[c] R. E. Aitchison. Some Effects of Certain Diets Upon Excretion by the Kidneys and by the Blood. Edinburgh, 1896. Cited by Dunlop; Report Prison Dietaries. Glasgow, 1899, p. 127.

[d] J. C. Dunlop. Supplement to Report Board of Commissioners in Lunacy. Scotland, 43 (1902), p. 92.

[e] Forster. Cited from U. S. Dept. Agr., Office Expt. Stas. Bul. 21.

[f] G. A. Sutherland. A System of Diet and Dietetics. London, 1908, p. 731.

***Summary of studies in public institutions and studies with, and standards for, aged persons*—Continued.**

Study No.	Location and subjects of studies.	Number of persons in study.	Nutrients and energy.					
			In food eaten.		In food wasted.		Proportion in food wasted.	
			Protein.	Energy.	Protein.	Energy.	Protein.	Energy.
	STUDIES WITH INDIVIDUALS.		Grams.	Calories.	Grams.	Calories.	Per cent.	Per cent.
	Woman, 79 years old, weight 38 kilograms, 1st study [a]		71	1,289				
	Woman, 79 years old, weight 38 kilograms, 2d study [a]		71	1,291				
	Woman, 81 years old, weight 37 kilograms [a]		71	1,226				
	Woman, 76 years old, weight 45 kilograms, 1st study [b]		77	1,361				
	Woman, 76 years old, weight 45 kilograms, 2d study [b]		66	1,361				
	Woman, 76 years old, weight 45 kilograms, 3d study [b]		66	1,165				
	Woman, 78 years old, weight 61 kilograms, 1st study [b]		41	1,275				
	Woman, 78 years old, weight 61 kilograms, 2d study [b]		41	1,575				
	Woman, 78 years old, weight 61 kilograms, 3d study [b]		67	1,207				
	Woman, 61 years old, 1st diet [c]		80	1,125				
	Woman, 61 years old, 2d diet [c]		85	1,200				
	Woman, 61 years old, 3d diet [c]		87	1,230				
	Woman, 61 years old, 4th diet [c]		84	1,600				
	DIETARY STANDARDS.							
	Voit's standards: [d]							
	Old man, no work		90	2,116				
	Old man, light work		100	2,689				
	Old woman, no work		80	1,831				
	Old woman, light work		85	2,096				
	Old people, hard work		100	2,898				
	Maurel's maintenance standards: [e]							
	Men, 60 years, average weight, 66 kilograms		82	1,965				
	Men, 70 years, average weight, 63 kilograms		79	1,891				
	Men, 80 years, average weight, 61 kilograms		46	1,531				
	Men, 90 years, average weight, 58 kilograms		43	1,446				
	Women, 60 years, average weight, 57 kilograms		71	1,702				
	Women, 70 years, average weight, 54 kilograms		67	1,612				
	Women, 80 years, average weight, 52 kilograms		39	1,288				
	Women, 90 years, average weight, 49 kilograms		37	1,234				
	U. S. Department of Agriculture standards: [f]							
	Man, moderate muscular work, period of full vigor—							
	Food purchased		115	3,800				
	Food eaten		100	3,500				
	Old man or woman—							
	Food purchased		104	3,400				
	Food eaten		90	3,150				
	Extreme old age, man or woman—							
	Food purchased		81-90	2,660-3,040				
	Food eaten		70-80	2,450-2,800				

[a] von Limbeck. Ztschr. Klin. Med., 26 (1894), p. 437.
[b] Kovesi. Centbl. Inn. Med., 22 (1901), No. 5, p. 121.
[c] Fenger. Skand. Arch. Physiol., 16 (1904), p. 222.
[d] Ztschr. Biol., 12 (1876), p. 32.
[e] See page 82.
[f] U. S. Dept. Agr., Yearbook 1907, p. 361.

In the studies made in the three Baltimore homes for the aged, none of the diets provided more than the 85 grams of protein called for by the suggested standard for persons in the decline of life, and in one case the diet provided only 74 grams. Considering that the subjects all seemed satisfied with the amount of their food and that their general health was as good as could be expected at their age, the natural inference is that the suggested protein standard is ample for the nutritive needs of persons in extreme age and with comparatively little activity—that, indeed, it may be possible to support life comfortably and well on a somewhat smaller amount, as Maurel's work has suggested. It does not necessarily follow, however, that the usual standard ought, therefore, to be reduced, for the latter is not intended to represent the minimum or even the average physiological requirement, but rather to suggest an amount ordinarily demanded by properly nourished subjects, and to serve as a basis in planning dietaries, especially in public institutions. Since in most public institutions economy is rigidly insisted on, there would be more danger to the comfort of the inmates from setting the standard too low than too high. From this point of view these studies seem to corroborate the propriety of the present protein standard. As regards the energy, two of the studies showed a consumption within 25 calories of the 2,200 calories suggested by the standard, while in the other it amounted to 2,339 calories per man per day. Certainly this does not indicate too high an energy value in the suggested standard.

Another interesting point suggested by these studies is the comparative requirements of men and women in extreme age. It will be recalled that the first study in the Baltimore private institutions was made in a home for aged women, the second in a similar institution for aged men, and the third in a home for the aged of both sexes. The protein consumption was highest in the first and lowest in the last. The energy consumed per man per day in the men's home was about 100 calories more than in either the women's home or that for both sexes; but it should be borne in mind that these men averaged a little younger and were perhaps also a little more active than the subjects in the other studies. These facts hardly sustain the ordinary assumption that the food requirements of women are only 0.8 of those of men of similar age and activity, but imply rather that, as has been pointed out by earlier observers (see p. 80), in extreme age the food needs of the two sexes become more or less identical.

Compared with the results of dietary studies of individuals reported by von Limbeck, Kövesi, and Fenger, and the estimated nutritive value of the diet proposed by Sir Henry Thompson, the groups studied in Baltimore and Philadelphia obtained in their diet an abundance of both protein and energy.

The studies here reported have already been discussed to some extent in comparison with other institutions (see pp. 43, 44).

The smallest amounts of protein and energy noted in the present studies among the aged were found in the home for aged women in Philadelphia. When we consider, however, that the average age of the inmates was about 78 years, and that their muscular activity was probably very slight, it seems not improbable that the 58 grams of protein and 1,882 calories of energy supplied by the diet were amply sufficient for their needs. According to Maurel, 39 grams of protein and 1,288 calories of energy is a maintenance ration for women of 80; the 19 grams of protein and 594 calories of energy in excess of this should be sufficient for the small amount of muscular exercise taken. Considering that in this study the food served was not limited in amount and at the same time appeared appetizing, so that the inmates were not prevented by lack of food or by distaste from eating all they needed, it may be taken to indicate that amounts lower than those suggested by Voit may be ample for persons in extreme age.

No special standards for the aged have been proposed hitherto as a result of data obtained in the Department of Agriculture nutrition work, as little material gained by experimental studies was available on which to base them. Voit's factors have usually been accepted as indicating an abundant ration for institution dietaries for the aged.

On the basis of the work reported in this bulletin and other available data, it seems fair to propose 0.9 as the factor representing the proportion of protein and energy required in old age by a man or woman as compared with a man at moderate muscular work during the period of full vigor, and 0.7 to 0.8 as the factor representing the relative food requirement for extreme old age. The actual quantities of protein and energy will vary according to the basis of comparison selected, whether it be food purchased, food eaten, or food digested.[a] The standard proposed is generous rather than the reverse and is in accord with American food habits, and seems a reasonable guide for use in institutions or homes in planning diet for the aged.

DIETARY STUDIES WITH CHILDREN AND THEIR RESULTS.

A large number of carefully conducted investigations on infant feeding have been reported, and the literature on the subject is extensive, but relatively few studies have been made in connection with the nutrition problems of older children.

Of recent work with infants, the investigations of Michel and Perret[b] on the rational feeding of infants from birth to 2 years

---

[a] U. S. Dept. Agr., Yearbook 1907, p. 61.

[b] Rev. Hyg. et Méd. Infant., 5 (1906), No. 6, p. 477.

may be mentioned as representing methods followed in the accumulation of data and the application of the results of highly technical experiments to the practical problems under consideration. When possible, everyone concedes that it is best that the infant should be breast fed, but when this is impossible substitutes for natural feeding must be found, and these authors have endeavored to establish a scientific ration for the artificial feeding of infants. They have taken as a basis for their calculation a large amount of experimental and empirical data which they summarize with respect to the average weight of new-born infants, the gain in weight during different periods, the nature of the gain in terms of the composition of the body, the amount and character of material ingested and egested by infants breast fed and nourished on cow's milk diluted with water and sweetened with milk sugar, the amount of energy eliminated by infants per kilogram of body weight and per square meter of surface area, and similar data.

According to the calculations which they give, an infant weighing 8 kilograms has a surface area of 3.696 square meters, and on the basis of 150 calories per square meter would require 554 calories of available energy for maintenance. The calculated amount of nitrogen necessary for a gain of 1 gram in body weight is 0.02179 gram. Taking account of these values, they propose a ration which can be modified to provide for the proper maintenance and growth, in accordance with the different weights of the infant at different periods, and report observations on the effects of feeding a number of infants in accordance with the method proposed.

Mention should also be made in this connection of important papers recently published by Rubner on nutrition processes during the growth of the child,[a] the theory of nutrition after completion of growth,[b] and problems of growth and length of life from the standpoint of energetics.[c]

In his theoretical discussion of diet during the period of growth Rubner emphasizes the importance of energy constituents, and gives reasons for his belief that the protein requirement of children has been sometimes overestimated.

In the second of the papers referred to theories of nutrition are discussed chiefly with reference to protein metabolism. This factor, the author states, varies according to the protein requirements of the cell, the cell with little protein retaining more of the protein supplied to it than one which is rich in this constituent. For this reason a large

[a] Arch. Hyg., 66 (1908), No. 1-2, p. 81.

[b] Arch. Hyg., 66 (1908), No. 1-2, p. 1.

[c] Arch. Hyg., 66 (1908), No. 1-2, p. 127; Sitzber. K. Preuss. Akad. Wiss., 1908, II, p. 32; Das Problem der Lebensdauer und seine Beziehungen zu Wachstum und Ernährung. München, 1908.

protein supply does not cause so great nitrogen excretion in the former case as in the latter.

The author discusses nitrogen metabolism and gain on a basis of the amount of nitrogen present in the body rather than on the usual basis of body weight. Cell function is the primary consideration in protein metabolism. The cleavage of protein accommodates itself to this factor, and there is a relationship between cell function and the size of the body. Within certain limits nitrogen metabolism is more rapid the more protein is supplied.

The problems pertaining to growth and length of life, Rubner discusses with reference to man and other mammals, particularly from the standpoint of energetics. With respect both to the amount of protein and energy required during the nursing period to double the body weight, man, he states, forms an exception to the other mammals included in the discussion, in that on a uniform basis of comparison he requires smaller quantities of protein and about six times as much energy, the domestic mammals requiring on an average, according to the author's calculations, 4,808 calories for building a kilogram of body material.

A comparison is also made between man and other mammals with respect to the proportion of energy supplied during the nursing period which is retained in the body. In this respect man also differs from the ordinary domestic animals, since he retains only 5.2 per cent of the net energy supplied, in comparison with 34.3 in the case of domestic animals. This value is called by the author "quotient of growth." He estimates further that in domestic animals the ratio of food supply to maintenance is 202 to 100, and in man 120 to 100, so that in the case of domestic animals 69 per cent of the material supplied is retained, in comparison with 6.2 per cent in the case of man.

According to Rubner's summary, the time required by the young animal for doubling the body weight is inversely proportional to the intensity of metabolism, and therefore the shorter the period of growth the greater the metabolism of energy. The intensity of energy metabolism is a function of surface area, and therefore small animals show the more rapid growth.

In his discussion of the duration of life Rubner estimates that in the domestic animals each kilogram of body weight after growth is completed requires practically the same quantity of energy. Man forms an exception to this rule, in that he requires about four times as much as the other mammals. It follows, therefore, that man requires a greater proportional energy supply than other mammals.

The nutrition publications of this Office and other similar publications commonly give factors showing the dietary requirements of children in comparison with adult man at moderate work. These deduc-

tions very largely depend upon experimental evidence reported by Voit and others, which has been summarized in previous publications of this Office,[a] including the classic work of Camerer with his own children at different ages, and studies with other children by Forster, Uffelmann, Hasse, Schroeder, and Prausnitz, together with later work by Magnus-Levy, Pautz, and others.

Camerer's[b] work is especially noteworthy, both for its extent and the thoroughness with which it was conducted. Details of foods consumed, gains in weight and height, and similar data are recorded, as well as the results of extensive digestion experiments and studies of the income and outgo of nitrogen. The results obtained in Camerer's earlier work have been summarized in the Department of Agriculture publications referred to above, and are included in averages given in the table on page 94.

In a publication which appeared more recently he considers the whole question from the standpoint of metabolism from birth to the end of the period of growth.[c] His later work with children has to do more particularly with infants and their digestion, metabolism, and growth.[d]

Maurel's extensive work and deductions regarding the food of children are referred to elsewhere (see p. 95) in a discussion of the dietary studies reported in this bulletin.

A few studies with infants and children have been reported in connection with the nutrition investigations of this Office, though the amount of this work is limited, owing to general conditions under which the enterprise has been conducted. Atwater and Woods[e] report dietary work with an infant, while Jaffa, of the California Experiment Station, reports similar work and studies of children living on a fruitarian diet.[f]

As regards general discussions of the feeding of children, particularly during periods of infancy, the literature is perhaps more extensive than is the case with almost any other question of dietetics.

---

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 21 and 45.

[b] Ztschr. Biol. (1880), p. 24; (1882), p. 220; (1884), p. 556; (1888), p. 141; (1893), pp. 227, 398.

[c] Der Stoffwechsel des Kindes von der Geburt bis zur Beendigung des Wachstums. Tübingen, 1896.

[d] Die Verdauungsarbeit, ihre Grösse und ihr Einfluss auf den Stoffwechsel, insbes. den Stoffwechsel des Säuglings. 1900. Reprinted from Jahrb. Kinderheilk., n. ser., 51 (1900), p. 26.

Zur Physiologie des Säuglingsalters. Berlin, 1902. Reprinted from Jahrb. Kinderheilk., n. ser., 56 (1902), p. 543.

Die körperliche Entwicklung, die Ernährung und Pflege des Kindes. Stuttgart, 1902.

[e] Connecticut Storrs Sta. Rpt. 1895, p. 129.

[f] U. S. Dept. Agr., Office Expt. Stas. Buls. 107, 132.

Of recent discussions of the diet of children may be mentioned the monograph by Miss Caroline L. Hunt on the food of school children.[a] which sums up the bulk of the published literature on this subject.

As to the character of the different meals, Miss Hunt states that, while a general idea of the amount of food required should be kept in mind, no special effort need be made to balance each meal.

In general, the simplest foods should be given at night. Bread, milk, and simple sweets, like stewed fruits or plain cake, make a good supper for little children. The most important parts of the breakfast are milk, cereal or toast, and fruit. The question arises with school children whether the heavy meal ought to be at noon or night. At noon the meal may interfere with the afternoon work, at night with sleep. It should be remembered that the heavy meal usually means the one which includes meat. The nourishment obtained by the grown person from meat is secured by the child from milk. This may be so distributed through the different meals that there need be no especially large meal. The lunch taken by older people, with the addition of milk, can be considered the dinner of the child. His supper can then precede the regular dinner of the family, and be very simple though nutritious. For school children a warm liquid is desirable at noon. This may be soup or cocoa. Chocolate is too rich. The fact that fats remain longer in the stomach than other substances makes it particularly undesirable to serve fatty foods at noon if the child is to return soon to work.

Many of the medical text-books and works of reference on diet under conditions of health and disease take up the question of the feeding of children of different ages. In an article of this character which forms a part of recent work on dietetics and which embodies the results of clinical experience as well as other information, G. A. Sutherland[b] summarizes and discusses a large amount of information on the feeding of infants before and after weaning and of children from the second to the seventh year and during school life.

As regards diet from the second to the seventh year, the period characterized by active exercise, it calls for "an increased amount of carbohydrates and of proteins; in other words, of energy-producing and muscle-forming materials," as compared with the previous diet, and, according to the author, should be made up of simple foods, such as milk, eggs, butter, cream, minced or finely cut meat, fish, vegetable soups, light meat soups, cereals, simple puddings, vegetables, and fruits.

Bread forms a most important element in the diet. The amount of bread and butter or jam that an active 4-year-old child will consume at a meal is astonishing. Care must be taken, however, that the butter or jam is not the element which makes the bread go down. White or brown bread may be used, and it should be at least twenty-four hours old. It may be plain or toasted. All plain biscuits are also to be allowed, sweetened ones being regarded as an occasional luxury * * *.

---

[a] Bur. of Ed. [U. S.] Bul. 3, 1909, p. 7.

[b] A System of Diet and Dietetics. London, 1908, pp. 743-799.

The natural demand of the organism for sugar must be fully satisfied, and it is better to do so by the use of sugar in the food than by the artificial products of the manufacturer, which are often taken in excess apart from meals. Puddings and stewed fruit can be suitably sweetened. Honey, sirup, and jam can be taken with bread, biscuits, and puddings. At the same time it is not advisable to ruin the taste for plain foods by oversweetening a number of the dishes.

Fruits contain a considerable amount of sugar in a very assimilable form * * *. In hot weather it will be found useful to reduce the amount of the more substantial elements of the diet and to increase the amount of the fruit and vegetables. Special care must be taken to insure that the fruit is in proper condition, i. e., neither unripe nor too ripe, as unwholesome fruit disturbs the alimentary tract most seriously * * *.

The training in mastication should be perseveringly continued by the use of some hard articles of food. Until this is learned it may be necessary to give meat in a pounded, minced, or shredded form. The habit of bolting the food, acquired from the fluid diet of infancy, must be checked, and a slow methodical habit of eating should be acquired early in life.

In considering diet during school life, Sutherland considers the problem both with reference to home conditions and the boarding-school system which, particularly for boys, is such a characteristic feature of English school life. At about the eighth year, when the author assumes that school life begins, the child has reached an age when—

In addition to the requirements of the body for growth, repair, and exercise, we have to consider the work of the brain in connection with the diet. It is recognized by all that a growing boy or girl requires a large amount of nourishing food, and that at the same time the amount varies very largely with the individual. Consequently it is not advisable to stuff the child who does not appear to come up to an imaginary standard, or to starve the child who seems to go beyond it. If the child is having a duly apportioned amount of work and play, of sleep and out-of-door exercise, his appetite will be the best guide as to the amount of food required. The appetite must be a healthy one, i. e., trained on a diet of wholesome, plain foods, for a pampered appetite, previously developed on dainty highly seasoned dishes, can not be regarded as of any value whatever as a test.

If the appetite is debased in any way Doctor Sutherland emphasizes the importance of special study and special treatment.

As with adults, a very important factor in determining the amount of food is the physical work performed. The amount of exercise which a child takes in the open air will have a direct influence on the appetite and also on the quantity of food he should take. Exercise before food should not be pushed to the extent of producing exhaustion, or both the appetite and the digestion will be impaired. The natural man tends to rest after a meal, but the healthy child will be eager for exercise. Consequently it is not necessary to forbid such exercise, provided that it is of the nature of play, and not of a tiring character.

The quality of the diet should be such that a due proportion of proteins, carbohydrates, and fats enter into it. The chief difference from the feeding in earlier years is that a larger amount of beef and mutton is called for. Although the proteins required can be supplied in other foods, meat has the advantages of being the most concentrated, the most digestible, and the most palatable form in which they can be given. Meat should be given twice a day * * *. Additional proteins are to be supplied in the form of milk, eggs, oatmeal, etc.

The quality of the food is a matter of great importance, to which the author devotes particular attention.

If from any reason * * * a distaste for meat or vegetables is produced, the result will be that the feeling of hunger will lead the boy to satisfy it by eating undesirable things, such as sweets, pastry, etc., in excess. These latter appeal to the boyish appetite at all times, and are not in themselves injurious when given in moderation at meals. It is when wholesome and appetizing food is not supplied at table that the habit of eating unwholesome things between meals is developed.

The quality of the food depends greatly on the cooking. As plain cooking is all that a healthy boy's appetite demands, it is not asking too much to say that the food ought always to be well cooked * * *.

Tea and coffee may be added to the dietaries hitherto given, but should not be taken in excess or too strong. Milk at this age will be taken much more readily if flavored with tea or coffee * * *.

The chief meals of the day should be three in number—breakfast, dinner, and supper. Of these the first two should be the substantial meals, while supper should consist of less stimulating material * * *. There should be no hurrying over meals, no bolting of the food * * *. With three good meals in the day no boy should suffer from hunger or from failure of nutrition from lack of food. While greediness as regards food must be checked in certain cases, as it breeds physical ills if tolerated, one must not allow a healthy appetite to remain unsatisfied on the ground that moderation is a desirable virtue.

It would be possible to greatly extend the citations of deductions and opinions of investigators and writers on the subject of the feeding of children, but perhaps enough has been quoted to indicate the extent of the work, the character of the evidence on which conclusions are based, and the deductions of some of those who have approached the subject from the standpoint of the physician, the investigator, and the educator.

The results of the investigations in Baltimore and Philadelphia are summarized in the table which follows, together with the results of some data from other sources.

Dietary studies with and standards for children.

Description of study or standard.	Number of persons.	Average age.	Average weight.		Protein per day.	Energy per day.
STUDIES IN BALTIMORE AND PHILADELPHIA.		*Years.*	*Pounds.*	*Kilograms.*	*Grams.*	*Calories.*
Home for Colored Children, Baltimore, boys.	25	9	58.6	26.6	50	1,677
German Orphan Asylum, Baltimore, boys.	58	12	59.2	26.9	65	1,798
German Orphan Asylum, Baltimore, girls.	57	12	74.3	33.7		
Orphan Asylum, Philadelphia, boys	36	9	[a] 62	28.1	68	1,876
Orphan Asylum, Philadelphia, girls	44	11	[a] 69	31.3		
Average of above studies		10	67	30.4	61	1,784
FOREIGN STUDIES.						
Children, 2–6 years [b]	14	4	33	15	53	1,245
Children, 6–10 years [b]	8	8	53	24	65	1,575
Children, 10–14 years [b]	13	12	70	31.8	72	1,780
Children, 6–15 years, Orphan Asylum, Munich [c]					79	1,680
Boys, 8–15 years, Children's Home, Rostock [d]	38				87	2,905
Girls, 14–19 years, Industrial School, Essen [e]	71	15½			101	2,815
Boy [f]	1	15			98	1,960
Boy, average of 2 studies [g]	1	16			106	3,250
SUGGESTED MAINTENANCE REQUIREMENTS. [h]						
Child		2	22	10	18	675
Do		3	26.5	12	22	792
Do		5	33.1	15	26	937
Do		7	39.7	18	32	1,053
Do		8	44.1	20	35	1,130
Do		10	55.1	25	42	1,350
Do		12	66.1	30	53	1,545
Do		14	88.2	40	70	1,720
Youth		16	110.2	50	85	2,213
Do		18	121.3	55	94	2,406
Do		20	132.3	60	103	2,565
Early maturity		25	143.3	65	103	2,567
Do		30	143.3	65	90	2,405
U. S. DEPARTMENT OF AGRICULTURE STANDARDS. [i]						
Child, 2–5 years (0.4 food of man)			[j] 35	15.9	42	1,400
Child, 6–9 years (0.5 food of man)			[a] 55	24.9	53	1,750
Boy, 10–11 years (0.6 food of man)			[a] 67	30.4	63	2,100
Boy, 12 years (0.7 food of man)			[a] 78	35.4	74	2,450
Boy, 13–14 years (0.8 food of man)			[a] 85	38.6	84	2,800
Boy, 15–16 years (0.9 food of man)			[j] 117	53.7	95	3,150
Girl, 10–12 years (0.6 food of man)			[a] 69	31.3	63	2,100
Girl, 13–14 years (0.7 food of man)			[a] 89	40.4	74	2,450
Girl, 15–16 years (0.8 food of man)			[j] 111	50.4	84	2,800

[a] Metropolitan Life Insurance Company tables.
[b] Forster, Camerer, Uffelman, and Hasse. From Summary in U. S. Dept. Agr., Office Expt. Stas. Bul. 21. See also U. S. Dept. Agr., Office Expt. Stas. Bul. 45.
[c] Voit. Untersuchung der Kost, p. 125.
[d] Schröder. Arch. Hyg., 4 (1886), p. 39.
[e] Prausnitz. Arch. Hyg., 15 (1892), p. 387.
[f] Pautz. Ztschr. Biol., 37 (1895), p. 206.
[g] Magnus-Levy. Arch. Physiol. [Pflüger], 53 (1893), p. 547.
[h] Bowditch. Loc. cit.
[i] U. S. Dept. Agr., Yearbook 1907, p. 361.
[j] Maurel. Loc. cit.

It is commonly assumed that growing children need more nutrients in proportion to their size than adults, first, because extra material is needed for bodily growth; and second, because they have a proportionately larger body surface and require more energy to make good the greater evaporation through the skin. Since girls 6 years old or more usually weigh less than boys of corresponding age, it is also assumed that their nutritive requirements are slightly less. From these assumptions and the practical observations available, the nutri-

tive requirements of children of various ages as compared with those of adults have been calculated. Those given by Atwater and most commonly used in this country are as follows:

Child under 2 years old requires 0.3 the food of a man at moderately active muscular work.

Child 2–5 years old requires 0.4 the food of a man at moderately active muscular work.

Child 6–9 years old requires 0.5 the food of a man at moderately active muscular work.

Boy 10–11 and girl 10–12 years old require 0.6 the food of a man at moderately active muscular work.

Boy 12, and girl 13–14 years old require 0.7 the food of a man at moderately active muscular work.

Boy 13–14, and girl 15–16 years old require 0.8 the food of a man at moderately active muscular work.

Boy 15–16 years old requires 0.9 the food of a man at moderately active muscular work.

Maurel[a], whose work regarding the nutritive requirements in age, has already been referred to, has made equally elaborate studies of the requirements of children of different ages and weights. He assumes that, exclusive of the extra requirements occasioned by greater body surface, growth, and increasing internal muscular work, the protein required for a bare maintenance ration is the same with children as with adults in full vigor, namely, 1.5 grams per kilogram of body weight. In addition, he allows 0.15 gram for increasing internal muscular work. For growth, 0.10 gram is allowed up to 16 years and from 16 to 20 only 0.05 gram. This makes a total of 1.75 grams of protein per kilogram of body weight up to the age of 16 and from then to 20 years 1.70 grams. There are more variations in the amounts of energy required at different ages because the ratio of body surface to weight is constantly diminishing. For children of 2 years, 67.5 calories per kilogram of body weight is suggested, with gradually decreasing amounts until at 20 years only 42.75 calories are called for. Taking Quatelet's figures for the average weights of normal children of various ages, Maurel has calculated the amounts of protein and energy necessary, and these figures are given in the table (p. 97). It should be noted that these body weights run lower than the American ones quoted in connection with the Baltimore studies (see p. 94). Whether American children really develop faster than European, or whether different methods of weighing account for the variations is not known, but the heavier weights seem safer guides in fixing American standards. While Maurel's maintenance rations provide for normal growth and the exertion required by the performance of involuntary physiological functions, they make no allowance for external muscular work. Considering the activity

[a] Loc. cit.

and restlessness of most healthy children, it is probable that this would call for considerable extra energy, even though the children have no fixed muscular work such as that entailed upon many adults by their occupations. It would be practically impossible to estimate the energy thus expended, unless possibly by comparisons with and deductions from the results of many more dietary studies than are now available. Meanwhile, Maurel's figures are not only theoretically interesting, but also practically useful as a check on actual dietaries. To be on the safe side it would seem that the food should be in excess of these maintenance values.

In attempting to set up or to apply dietary standards for children, the question of body weight is more important than in adults, both because it is more variable and because it is a measure of the child's proper growth and general development. Various estimates of the average weight of American children at successive ages have been made. Among these may be mentioned those of Boston school children of American parentage, collected by Bowditch,[a] similar ones by Porter[a] in St. Louis, and those of the large life insurance companies. These statistics do not agree as closely as might be wished, differences of 1 or 2 pounds sometimes appearing. Whether the differences are due to methods of weighing, or whether the variations in children's weights are too great to permit of satisfactory averaging, it is impossible to say. When body weights were not given in the original studies those quoted by Holt from life insurance data for children of corresponding ages have usually been employed, in the table on page 94, as representing the largest number of individuals. In a few instances where these were not available those of Bowditch have been used. As has already been pointed out, the American figures all run higher than the French ones quoted by Maurel; although there is no conclusive explanation of this difference, it will be safer, in applying Maurel's maintenance rations to American conditions, to be guided by body weight rather than by age. Considering the bad results of undernutrition in childhood, the benefit of any possible doubt as to the exact requirements of children, especially in institutions, should unquestionably be given to the more generous ration. If, as an English children's specialist, Sir Clement Duke,[b] insists, "a failure in height or weight during growth is the surest indication that the child is not thriving," such symptoms occurring where the daily supply of nutrients is known to be rather low, should raise serious doubts as to the adequacy of the ration.

In a study of undernutrition of school children in New York, which included some 210 cases, E. M. Sill,[c] found that they had been living

[a] Diseases of Infancy and Childhood. New York, 1902, p. 19.
[b] Remedies for the Needless Injuries to Children, etc. London, 1899.
[c] Jour. Amer. Med. Assoc., 52 (1909), p. 1981.

very largely on bread with tea or coffee; that is, on a diet which was presumably low in both protein and energy, and that they were decidedly under weight—the discrepancy varying from 4 to 16 pounds. The children ranged from 3 to 10 years in age—the majority, however, being 6 to 10 years old. In addition to hygienic measures, these children were provided with a diet containing a generous proportion of proteid foods such as milk, eggs, meat, cereals, etc., which resulted in gains in weight and very marked improvement in other respects.

In this connection it may be interesting to see how the commonly accepted standards for children's dietaries compare with Maurel's maintenance rations, which can be done if the protein and energy per kilogram body weight are calculated as in the following table:

Children's dietary standards expressed per kilogram of body weight.

	Grams of protein.	Calories of energy.		Grams of protein.	Calories of energy.
Child, 2-5 years	2.43	87.5	Boy, 15-16 years	1.77	58.7
Child, 6-9 years	2.12	70.0	Girl, 10-12 years	2.01	67.1
Boy, 10-11 years	2.10	70.0	Girl, 13-14 years	1.83	60.6
Boy, 12 years	2.09	69.2	Girl, 15-16 years	1.66	55.6
Boy, 13-14 years	2.18	72.5			

Maurel's maintenance ration, it will be remembered, calls for 1.75 grams of protein per kilogram of body weight from birth to the age of 16, when it is reduced to 1.70 grams, and amounts of energy gradually decreasing for 67.50 calories at birth to 44.25 at 16 years. The common standard for children from 2 to 5 years of age gives an excess of 0.68 gram of protein over this maintenance ration, but this excess gradually decreases in the standards for older children, until for boys from 15 to 16 years it is only 0.02 gram, while for girls from 15 to 16 years there is a deficiency of 0.9 gram. Even if we adopt Maurel's lowered ration of 1.70 grams per kilogram of body weight for children of 16 years, the protein in the last standard for girls falls below the maintenance ration. There is a similar but less marked decrease in the excess of energy in the usual standards over that of the maintenance rations, the excess varying from about 20 calories per kilogram of body weight in the standard for children from 2 to 6 years to 11.3 calories in that for girls of 15 to 16 years. The inferences from these comparisons are obvious; either the American weights used are too large and the standards for younger children are somewhat excessive, or the standards for older children are insufficient to provide for normal amounts of external muscular work. While the weights here used may not be absolutely accurate, there is no reason to suppose that they are greatly above the normal for well-developed American children. In the opinion of the present writers, it is probably nearer the truth, and certainly safer for the present, to

assume that the standards for older children are a trifle low, especially for institution use.

Reducing the data of the present studies in children's homes as summarized in the table on page 94 to the basis of protein and energy supplied per kilogram of body weight, we obtain the following results:

Protein and energy per kilogram of body weight in children's dietaries.

Institution.	Grams of protein.	Calories of energy.
Maryland Home for Friendless Colored Children	1.88	63.0
General German Orphan Asylum	2.15	59.3
Philadelphia Orphanage	2.29	63.2
Average	2.01	58.7

In the first of these studies there are only 0.13 gram of protein and 9 calories of energy in excess of the amounts set up by Maurel as a maintenance ration for children of corresponding weight. In the diet of the German Orphan Asylum there is an excess of 0.4 gram protein, but only 6.8 calories more energy than in the maintenance ration. In the Philadelphia study 0.54 gram of protein and 11.7 calories of energy were supplied in excess of Maurel's maintenance ration.

While it is impossible to estimate the amount of external muscular work performed by the children in these studies, they are known to have been moderately active, and it seems impossible that their diet can have been excessive in either protein or energy. On the other hand, it is questionable whether the protein in the first study or the energy in the second can have been sufficient for their best development. It was noted in the individual discussions of these two studies that while the nutrients and energy supplied by the diets corresponded fairly closely to the generally accepted standards, the children appeared to the observer to be rather below the average in general physical development. While there was little sickness in the institutions, the children gave the impression of being younger than they were, and this before any effort had been made to weigh them. In the case of the German Orphan Asylum the body weights were carefully taken, so that there is little likelihood of error from that source. Here again, as in the case of the standards for older children, the most reasonable deduction seems to be that the present standards for children from 9 to 12 years old are a trifle low. Many more observations of the diet of normal children are necessary before the exact amounts required can be determined. In the light of our present knowledge it seems fair to conclude that it would not be wise to allow anything below the standard amounts in children's diets, and in most cases dietitians would be quite justified in exceeding them somewhat.

O

 Issued February 1, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN 224.

A. C. TRUE, Director.

ORGANIZATION LISTS OF THE

AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS

IN THE UNITED STATES.

DECEMBER, 1909.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., October 26, 1909.

Sir: I have the honor to transmit herewith a manuscript containing the revised organization lists of agricultural colleges and experiment stations in the United States, which has been compiled under my direction by Miss Mary A. Agnew of this Office.

In these lists the plan started last year has again been followed, namely, to confine the lists to the names of administrative officers and instructors whose work brings them in contact with students in agricultural and home economics courses, omitting those who deal exclusively with mechanic arts or engineering students, but as formerly it has in some cases been found impracticable, owing to the complex organization of the institutions concerned, to make the lists entirely consistent.

I recommend the publication of this manuscript as Bulletin 224 of this Office.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

KEY TO ABBREVIATIONS.

NOTE.—Members of boards of trustees or other governing boards of the college who are charged with the management of experiment station affairs are indicated by an asterisk (*).

Acct., Accountant, Accounts.
Actg., Acting.
(*Actg.*), Acting Professor.
(*Adjunct*), Adjunct Professor.
Agr., Agriculture, Agriculturist, Agricultural.
Agron., Agronomy, Agronomist.
Agt., Agent.
Anal., Analytical, Analysis.
Anat., Anatomy.
Archi., Architecture.
Arith., Arithmetic.
Assoc., Associate.
(*Assoc.*), Associate Professor.
Asst., Assistant.
(*Asst.*), Assistant Professor.
Astron., Astronomy.
Bact., Bacteriology, Bacteriologist.
Bibliog., Bibliography, Bibliographer.
Biol., Biology, Biologist, Biological.
Blacksm., Blacksmithing.
Bot., Botany, Botanist, Botanical.
Chair., Chairman.
Chem., Chemist, Chemistry, Chemical.
Climat., Climatology, Climatologist.
Comdt., Commandant.
Coml., Commercial.
Comr., Commissioner.
Corresp., Correspondence, Correspondent.
Dept., Department.
Dir., Director.
Div., Division.
Dom., Domestic.
Draw., Drawing.
Econ., Economy, Economic, Economics.
Ed., Education.
El., Elementary.
Elect., Electrical, Electricity.
Engin., Engineer, Engineering.
Engl., English.
Ent., Entomology, Entomologist.
Expt., Experiment, Experimental, Experimentalist, Experimenter.
Ext., Extension.
Feed., Feeding.
Fert., Fertilizer.
Flor., Floriculture, Florist.
For., Forestry.
Gard., Gardener, Gardening.
Gen., General.
Geog., Geography.
Geol., Geology, Geologist, Geological.
Gov., Governor.
Hist., History, Historical.
Hort., Horticulture, Horticulturist.
Husb., Husbandry, Husbandman.
Hyg., Hygiene.
Indus., Industrial, Industries, Industry.
Inorg., Inorganic.
Insp., Inspector, Inspection.
Insts., Institutes.
Instr., Instruction, Instructor.
Invest., Investigations.
Irrig., Irrigation, Irrigationist.
Lab., Laboratory.
Lang., Language, Languages.
Lat., Latin.
Lect., Lecturer.
Libr., Library, Librarian.
Lit., Literature.
Mach., Machine, Machinery, Machinist.
Math., Mathematics.
Mech., Mechanics, Mechanician, Mechanical.
Met., Meteorology, Meteorologist.
Metal., Metallurgy.
Mfg., Manufacturing.
Mgr., Manager.
Mil., Military.
Min., Mineralogy, Mineralogist, Mining.
Mod., Modern.
Myc., Mycology, Mycologist.
Nat., Natural.
Oler., Olericulture, Olericulturist.
Org., Organic.
Ornith., Ornithology.
Path., Pathology, Pathologist.
Pedag., Pedagogy, Pedagogics.
Pharm., Pharmacy, Pharmacist.
Philos., Philosophy.
Photog., Photography.
Phys., Physics, Physicist, Physical.
Physiol., Physiology, Physiologist, Physiological.
Polit., Political.
Pomol., Pomology, Pomologist.
Pract., Practice, Practical.
Prep., Preparatory.
Pres., President.
Prin., Principal.
Print., Printing.
Psych., Psychology.
Rhet., Rhetoric.
Sci., Science, Scientific.
Sec., Secretary.
Sew., Sewing.
Sociol., Sociology.
Sta., Station.
Sten., Stenography, Stenographer.
Substa., Substation.
Supt., Superintendent.
Tech., Technology, Technical.
Treas., Treasurer.
Typew., Typewriting, Typewriter.
Univ., University.
V. Dir., Vice-Director.
Veg., Vegetable, Vegetation.
Vet., Veterinary, Veterinarian.
Vit., Viticulture, Viticulturist.
V. Pres., Vice-President.
Wheelwr., Wheelwrighting.
Zool., Zoology, Zoologist.

THE OFFICE OF EXPERIMENT STATIONS.

A. C. True, Ph. D., Sc. D., Director.
E. W. Allen, Ph. D., Assistant Director and Editor of Experiment Station Record.
W. H. Beal, A. B., M. E., Chief of Editorial Division.
Mrs. C. E. Johnston, Chief Clerk.
Sarah L. Sommers, Record Clerk.
E. Lucy Ogden, Librarian.

Editorial Departments.

L. W. Fetzer, Ph. D., Agricultural chemistry and agrotechny.
W. H. Beal, Meteorology, soils, and fertilizers.
W. H. Evans, Ph. D., Agricultural botany and vegetable pathology.
J. I. Schulte, B. S.,
J. O. Rankin, A. B., B. S. A., } Field crops.
E. J. Glasson, B. S. A., Horticulture and forestry.
C. F. Langworthy, Ph. D., Foods and human nutrition.
E. W. Morse, B. S. A., Zootechny, dairying, and dairy farming.
W. A. Hooker, B. S., Economic zoology, entomology, and veterinary medicine.
J. B. Morman, M. A., Rural economics.
D. J. Crosby, M. S., Agricultural education.
H. L. Knight, B. S., Editorial assistant.
T. K. Burrows, B. A., Editorial assistant.
William Henry, Indexing and proof reading.

Insular Stations.

W. H. Evans, Ph. D., Chief.

ALASKA EXPERIMENT STATIONS.

C. C. Georgeson, M. S., Special agent in charge, Sitka.
R. W. De Armond, Assistant at Sitka.
G. W. Gasser, B. S., Assistant at Rampart.
M. D. Snodgrass, B. S., Assistant at Kodiak.
Laurence Kelly, Assistant dairyman at Kodiak.
J. W. Neal, Assistant at Fairbanks.

HAWAII EXPERIMENT STATION.

E. V. Wilcox, Ph. D., Special agent in charge, Honolulu.
J. E. Higgins, B. A., M. S. A., Horticulturist.
F. G. Krauss, Agronomist.
W. P. Kelley, M. S., Chemist.
D. T. Fullaway, A. B., Entomologist.
Alice R. Thompson, B. S., Assistant chemist.
C. J. Hunn, B. S. A., Assistant horticulturist.
Q. Q. Bradford, Assistant in rubber investigations.
Valentine Holt, Assistant agronomist.

PORTO RICO EXPERIMENT STATION.

D. W. May, M. Agr., Special agent in charge, Mayaguez.
J. W. van Leenhoff, Coffee expert.
W. V. Tower, B. S., Entomologist.
P. L. Gile, A. B., Chemist.
C. F. Kinman, B. S., Horticulturist.
E. G. Ritzman, Assistant animal husbandman.
G. L. Fawcett, Assistant plant pathologist.
W. C. Taylor, B. S., Assistant chemist.
T. B. McClelland, Assistant horticulturist.
W. E. Hess, Expert gardener.

GUAM EXPERIMENT STATION.

J. B. Thompson, B. S., Special agent in charge, Island of Guam.
H. L. V. Costenoble, Assistant.

AGRICULTURAL EDUCATION.

D. J. CROSBY, M. S., Specialist in agricultural education.
F. W. HOWE, M. S., Assistant in agricultural education.
JOHN HAMILTON, B. S., M. S. A., Farmers' institute specialist.
J. M. STEDMAN, B. S., Assistant farmers' institute specialist.

NUTRITION INVESTIGATIONS.

C. F. LANGWORTHY, Ph. D., Expert in nutrition investigations.
R. D. MILNER, Ph. B., Assistant in nutrition investigations.
W. P. GARRETY, B. S., M. A., Laboratory assistant.
S. C. CLARK, B. S., M. A., Laboratory assistant.

IRRIGATION INVESTIGATIONS.

SAMUEL FORTIER, D. Sc., Chief of irrigation investigations.
R. P. TEELE, M. A., Editorial assistant and acting chief in absence of the chief.

Irrigation engineers and irrigation managers.—A. P. STOVER, in charge of work in Oregon; C. E. TAIT, in charge of work in Imperial Valley and Arizona; S. O. JAYNE, in charge of work in Washington; W. W. MCLAUGHLIN, in charge of work in Utah; P. E. FULLER, in charge of power investigations; W. L. ROCKWELL, in charge of work in Texas; M. B. WILLIAMS, in charge of work in humid sections; D. H. BARK, in charge of work in Idaho; V. M. CONE and C. G. HASKELL, *engineers*; F. G. HARDEN, *scientific assistant*.

Expert mechanician.—E. J. HOFF.

Irrigation farmers.—J. H. GORDON, R. G. HEMPHILL, W. H. LAUCK, R. E. MAHONEY, JOHN KRALL, Jr.

COLLABORATORS.

O. V. P. STOUT, in charge of work in Nebraska, University of Nebraska.
G. H. TRUE, in charge of work in Nevada, University of Nevada.
F. L. BIXBY, in charge of work in New Mexico, New Mexico College of Agriculture and Mechanic Arts.

DRAINAGE INVESTIGATIONS.

C. G. ELLIOTT, C. E., Chief drainage engineer and chief of drainage investigations.

Supervising drainage engineers.—J. O. WRIGHT, A. E. MORGAN, W. J. MCEATHRON, S. M. WOODWARD (special work).

Drainage engineers.—C. F. BROWN, L. L. HIDINGER, S. H. MCCRORY, H. A. KIPP, D. G. MILLER, F. F. SHAFER, J. T. STEWART (special work).

Assistant drainage engineers.—W. W. WEIR, O. G. BAXTER, H. R. ELLIOTT, G. R. BOYD, R. A. HART, G. M. WARREN, D. L. YARNELL, J. V. PHILLIPS, L. A. JONES, F. G. EASON, A. M. SHAW, C. W. OKEY.

Office engineer.—A. D. MOREHOUSE.

Assistant office engineer.—R. D. MARSDEN.

Draftsman.—G. F. POHLERS.

COLLABORATOR.

W. B. GREGORY, Tulane University of Louisiana.

OFFICERS OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

President.—W. J. KERR, of Oregon.

Vice-Presidents.—H. J. WATERS, of Kansas; W. P. BROOKS, of Massachusetts; C. A. LORY, of Colorado; P. H. ROLFS, of Florida; LUTHER FOSTER, of New Mexico.

Secretary-Treasurer.—J. L. HILLS, of Vermont.

Bibliographer.—A. C. TRUE, of Washington, D. C.

Executive committee.—W. O. THOMPSON, of Ohio, Chairman; J. L. SNYDER, of Michigan; W. E. STONE, of Indiana; W. H. JORDAN, of New York; C. F. CURTISS, of Iowa.

Sections.—Section on College Work and Administration: SAMUEL AVERY, of Nebraska, Chairman; W. D. GIBBS, of New Hampshire, Secretary. Committee on Programme: The CHAIRMAN and SECRETARY.

Section on Experiment Station Work; F. B. LINFIELD, of Montana, Chairman; H. L. RUSSELL, of Wisconsin, Secretary. Committee on Programme: The CHAIRMAN and SECRETARY, and W. H. BEAL, of Washington, D. C.

Section on Extension Work: A. M. SOULE, of Georgia, Chairman; G. I. CHRISTIE, of Indiana, Secretary.

Standing committees.—Committee on Instruction in Agriculture: For three years, J. F. DUGGAR, of Alabama, and W. E. STONE, of Indiana; for two years, A. C. TRUE, of Washington, D. C., Chairman, and T. F. HUNT, of Pennsylvania; for one year, H. T FRENCH, of Idaho, and H. C. WHITE, of Georgia.

Committee on Graduate Study: For three years, W. O. THOMPSON, of Ohio, and BROWN AYRES, of Tennessee; for two years, H. P. ARMSBY, of Pennsylvania, Chairman, and HOWARD EDWARDS, of Rhode Island; for one year, M. H. BUCKHAM, of Vermont, and EUGENE DAVENPORT, of Illinois.

Committee on Extension Work: For three years, A. M. SOULE, of Georgia, and E. A. BURNETT, of Nebraska; for two years, K. L. BUTTERFIELD, of Massachusetts, Chairman, and C. R. VAN HISE, of Wisconsin; for one year, W. C. LATTA, of Indiana, and C. F. CURTISS, of Iowa.

Committee on Experiment Station Organization and Policy: For three years, M. A. SCOVELL, of Kentucky, and L. G. CARPENTER, of Colorado; for two years, EUGENE DAVENPORT, of Illinois, Chairman, and C. D. WOODS, of Maine; for one year, H. J. WHEELER, of Rhode Island, and E. B. VOORHEES, of New Jersey.

OFFICERS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS OF THE UNITED STATES.

President.—W. A. WITHERS, of West Raleigh, N. C.

Vice-President.—F. W. WOLL, of Madison, Wis.

Secretary.—H. W. WILEY, U. S. Department of Agriculture, Washington, D. C.

Executive Committee.—The PRESIDENT; the VICE-PRESIDENT; the SECRETARY; J. M. BARTLETT, of Orono, Me.; J. T. WILLARD, of Manhattan, Kans.

OFFICERS OF THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

President.—G. A. PUTNAM, of Toronto, Canada.

Vice-President.—A. M. SOULE, of Athens, Ga.

Secretary-Treasurer.—JOHN HAMILTON, U. S. Department of Agriculture, Washington, D. C.

Executive Committee.—The PRESIDENT and the SECRETARY-TREASURER, ex officio; W. T. CLARKE, of Berkeley, Cal.; VAL KEYSER, of Lincoln, Nebr.; FRANKLIN DYE, of Trenton, N. J.

OFFICERS OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

President.—E. D. SANDERSON, of Durham, N. H.

First Vice-President.—H. T. FERNALD, of Amherst, Mass.

Second Vice-President.—P. J. PARROTT, of Geneva, N. Y.

Secretary.—A. F. BURGESS, U. S. Department of Agriculture, Washington, D. C.

OFFICERS OF THE SOCIETY FOR HORTICULTURAL SCIENCE.

President.—W. A. TAYLOR, U. S. Department of Agriculture, Washington, D. C.

Vice-Presidents.—G. B. BRACKETT, U. S. Department of Agriculture, Washington, D. C.; L. H. BAILEY, of Ithaca, N. Y.; S. A. BEACH, of Ames, Iowa.

Secretary-Treasurer.—C. P. CLOSE, of College Park, Md.

Assistant Secretary.—H. J. EUSTACE, of East Lansing, Mich.

Executive Committee.—W. A. TAYLOR (President ex officio), of Washington, D. C.; W. R. LAZENBY (Chairman), of Columbus, Ohio; W. M. MUNSON, of Morgantown, W. Va.; JOHN CRAIG, of Ithaca, N. Y.; C. P. CLOSE (Secretary ex officio), of College Park, Md.

AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

NOTE.—Members of boards of trustees or other governing boards of the college who are specially charged with the management of experiment station affairs are indicated by an asterisk (*).

ALABAMA.

Alabama Polytechnic Institute, *Auburn*.

GOVERNING BOARD.

Trustees: Gov. B. B. Comer (*Pres. ex officio*), *Montgomery;* H. C. Gunnels (*Supt. of Education, ex officio*), *Montgomery;* W. K. Terry, *Birmingham;* J. S. Frazer, *Mobile;* N. D. Denson, *Lafayette;* R. F. Ligon, jr., *Montgomery;* Tancred Betts, *Huntsville;* Wm. C. Davis,* *Jasper;* H. L. Martin, *Ozark;* R. B. Barnes, *Opelika;* A. W. Bell, *Anniston;* W. F. Feagin, *Montgomery;* J. H. Drake (*Surgeon*), *Auburn;* R. W. Burton (*Sec.*), *Auburn;* Miss M. A. Glenn (*Treas.*), *Auburn*.

COURSES OF STUDY.

There are nine regular four-year courses (B. S. degree), viz: Agriculture, civil engineering, electrical engineering, mechanical engineering, mining engineering, architecture, pharmacy, general course, and chemistry and metallurgy; three-year courses in pharmacy (Ph. C.) and in veterinary medicine and surgery (D. V. M.); two-year courses in agriculture (certificate), mechanic arts, and pharmacy (Ph. G.); a one-year course in agriculture, and a summer school for farmers. Postgraduate work is offered.

BOARD OF INSTRUCTION.

Charles C. Thach, M. A., LL. D., *President; English and Political Economy.*

George Petrie, Ph. D., *Dean of Academic Depts.; Hist., Lat.*
Bennett B. Ross, M. S., *Dean of Agr. Sci.; Gen. and Agr. Chem.; State Chem.*
John J. Wilmore, M. E., *Dean of Engin. Faculty; Mech. Engin.; Dir. of Laboratories.*
Charles A. Cary, B. S., D. V. M., *Dean College of Vet. Med. and Surgery; Physiol., Vet. Sci.; State Vet.; in charge of Farmers' Insts.*
John F. Duggar, M. S., *Agr.*
John E. Wiatt, M. A., *Mod. Lang.*
James P. C. Southall, M. A., *Phys.*
Roger S. Mackintosh,[a] B. Agr., *Hort., For.; State Hort.*
Benj. S. Patrick, M. S., *Comdt.; Mil. Sci.*
Geo. N. Mitcham, C. E., E. M., *Civil Engin.*
Bolling H. Crenshaw, B. S., M. E., *Math.*
Albert H. Wilson, M. S., *Math.*
Emerson R. Miller, M. S., *Pharm., Chem.*
Warren E. Hinds, Ph. D., *Ent.*
Michael T. Fullan, M. E., *Mech. Draw., Mech. Design.*
Clifford LeR. Hare, M. S., M. A., *Phys., Physiol. Chem.*
Daniel T. Gray, A. B., M. S., *Animal Indus.*
Francis E. Lloyd, A. M., *Bot.*
L. N. Duncan, M. S., *Agr. School Work.*
Reuben D. Webb, M. S., (*Assoc.*) *Rhet.*
James R. Rutland, A. B., (*Asst.*) *Engl.; Libr.*
William B. Stokes, M. E., *Instr. Mech. Arts.*
Thomas Bragg, M. S., *Instr. Chem.*
Berner L. Shi, C. E., *Instr. Math.*
Michael J. Donahue, A. B., *Phys. Dir.; Instr. Engl., Meth.*
Casper C. Certain, E. E., *Registrar; Instr. Engl.*
Cincinnatus D. Killebrew, M. S., *Instr. Phys.*
Wm. LeR. Mitchell, M. E., *Instr. Mech. Arts.*
Isaac S. McAdory, B. S., D. V. M., *Instr. Vet. Sci.*
Joseph W. Ridgway, B. S., *Asst. in Animal Indus.*
Percy F. Williams, B. S., (*Actg.*) *Hort.*
Charles S. Ridgway, B. S., *Instr. Bot.*
M. J. Funchess, B. S., *Instr. Agr.*
Chas. S. Williamson, jr., M. S., *Instr. Chem.*
William F. Turner, B. S., *Asst. in Ent.*
Carl G. Gaum, E. E., *Instr. Draw.*
Jacob A. Walker, B. S., *Instr. Hist., Lat.*
James L. Skinner, E. E., *Instr. Math., Asst. in Elect. Engin.*
Ernest W. Thornton, B. S., *Asst. in Chem.*
Emmett E. Binford, B. S., *Asst. in Bot.*
J. C. C. Price, B. S., *Asst. in Hort.*
Daniel Herren, B. S., *Asst. in Civil Engin.*
J. W. Powell, B. S., *Asst. in Mech. Engin.*
James G. Stelzenmuller, B. S., *Asst. in Civil Engin.*
William J. Russell, B. S., *Asst. in Chem.*
P. F. Bahnsen, V. S., *Lect. on Phys. Diagnosis.*

[a] On leave.

Agricultural Experiment Station of the Alabama Polytechnic Institute, *Auburn.*

Department of the Alabama Polytechnic Institute, under the control of the Board of Trustees.

STATION STAFF.

J. F. Duggar, M. S., *Dir.; Agr.*
B. B. Ross, M. S., *Chem.*
C. A. Cary, B. S., D. V. M., *Vet.*
R. S. Mackintosh,[a] B. Agr., *Hort.*
W. E. Hinds, Ph. D., *Ent.*
D. T. Gray, A. B., M. S., *Animal Indus.*
F. E. Lloyd, A. M., *Bot.*
J. T. Anderson, Ph. D., *Chem., Soil and Crop Invest.*
C. LeR. Hare, M. S., M. A., *Physiol. Chem.*
Thomas Bragg, M. S., *Asst. Chem.*
E. F. Cauthen, B. S., *Farm Supt.; Recorder.*
I. S. McAdory, B. S., D. V. M., *Asst. in Vet. Sci.*
P. F. Williams, B. S., *Actg. Hort.*
J. C. C. Price, B. S., *Asst. Hort.*
N. E. Bell, B. S., *Asst. Chem.*
W. F. Turner, B. S., *Asst. Ent.*
M. J. Funchess, B. S., *Asst. Agr.*
C. S. Williamson, jr., M. S., *Asst. Chem.*
L. W. Shook, B. S., *Asst. in Animal Indus.*

Agricultural and Mechanical College for Negroes, *Normal.*

GOVERNING BOARD.

Trustees: Gov. B. B. Comer, *Montgomery;* H. C. Gunnels (*Supt. of Education*), *Montgomery;* S. J. Mayhew (*Chair.*), *Huntsville;* D. A. Grayson (*Sec.*), *Huntsville;* Ben P. Hunt, *Huntsville.*

COURSES OF STUDY.

The college is divided into two departments—literary and industrial. The courses requiring four years for completion are as follows: Scientific, agricultural, and mechanical. Courses covering from one to four years are given in a number of different industrial and literary subjects.

BOARD OF INSTRUCTION.

Walter S. Buchanan, B. S. A., *President; Agriculture.*

W. O. Thompson, B. S., *Animal Indus.*
Miss H. K. Diffay, *Sew.*
Mrs. A. M. Boothe, A. B., *Cooking.*
Miss E. M. King, A. B., *Housekeeping.*
Mrs. H. Hopkins, *Laundering.*
Miss P. L. Shines, *Nurse Training.*
Miss M. J. Gibson, *Millinery.*
Luther A. Van Hoose, *Blacksm., Wheelwr.*

Canebrake Agricultural Experiment Station, *Uniontown.*

GOVERNING BOARD.

Board of Control: W. H. Tayloe (*Chair.*), *Uniontown;* J. A. Wilkinson (*Comr. of Agr. ex officio*), *Montgomery;* J. Huggins, *Newbern;* R. A. Hardie, *Uniontown;* Wm. Munford (*Treas.*), *Uniontown;* J. B. Garber, *Laneville;* J. F. Duggar, *Auburn.*

STATION STAFF.

F. D. Stevens, B. S., *Director in charge; Sec.*

Agricultural School of the Tuskegee Normal and Industrial Institute, *Tuskegee Institute.*

GOVERNING BOARD.

Board of Trustees: Seth Low (*Pres.*), *30 East Sixty-fourth st., New York City;* Wright W. Campbell* (*V. Pres.*), *Tuskegee;* Warren Logan* (*Treas.*), *Tuskegee Institute;* R. C. Bedford (*Sec.*), *832 Park ave., Beloit, Wis.;* George F. Peabody, *2 Rector st., New York City;* Paul M. Warburg, *52 William st., New York City;* Wm. G. Willcox, *27 William st., New York City;* H. H. Hanna, *Atlas Engine Works, Indianapolis, Ind.;* R. O. Simpson, *Furman;* Robert C. Ogden, *125 East Fifty-sixth st., New York City;* John C. Grant, *5651 Drexel boulevard, Chicago, Ill.;* V. H. Tulane, *433 South Ripley st., Montgomery;* Belton Gilreath, *Birmingham;* Chas. W. Hare,* *Tuskegee;* Booker T. Washington,* *Tuskegee Institute;* A. J. Wilborn,* *Tuskegee;* Charles F. Dole, *Jamaica Plain, Mass.;* Wm. J. Schieffelin, *170 William st., New York City.*

COURSES OF STUDY.

The institute is divided into five departments: Academic, Bible training school, mechanical industries, domestic economy or industries for girls, and agriculture.

---

[a] On leave.

The school of agriculture offers a four-year course in agriculture and two-year courses in live stock and dairying, truck gardening, poultry raising, agriculture, road building, landscape gardening, and fruit growing; also a two-year course in elementary agriculture for academic students. Postgraduate work is offered.

BOARD OF INSTRUCTION.

Booker T. Washington, *Principal.*

George W. Carver, M. S. Agr., *Dir. of Agr. Dept.*
Thos. N. Cowan, *Farm Supt.*
Geo. R. Bridgeforth, B. S., *Agr.*
A. A. Turner, *Dairying.*
H. H. Wheeler, *Dairying, Animal Husb.*
John W. Yates, *Care of Grounds and Greenhouse.*
C. W. Greene, *Truck Gard.*
E. L. Faulkner, *Fruit Gard.*
Mrs. Booker T. Washington, *Dir. Indus. for Girls.*
Maj. J. B. Ramsey, *Comdt.*
Capt. G. C. Austin, *Asst. to Comdt.*
Capt. W. H. Walcott, *Asst. to Comdt.*
S. M. Russell, *Dom. Sci.*
A. L. Evans, *Poultry Raising.*
Katie Davis, *Dom. Sci.*
Lillian R. Johnson, *Ladies' Tailoring.*
Hattie E. King, *Dressmaking.*
Margery E. Smith, *Plain Sew.*
Cornelia A. Vivian, *Millinery.*
Ophelia Donaldson, *Laundering.*
Ellen Burney, *Laundering.*
Carrie C. Smith, *Upholstering, Mattress Making.*
Octavia P. Ferguson, *Asst. to Dir.*
Mary E. Davis, *Housekeeping.*
Jane Weyman, *Housekeeping.*
Corrinne Judah, *Housekeeping.*
Rebecca J. Wright, *Housekeeping.*
John H. Palmer, *Registrar.*
Chas. W. Wood, *Libr.*
Amelia M. Cromwell, *Phys. Training.*

Tuskegee Agricultural Experiment Station, *Tuskegee Institute.*

Department of the Tuskegee Normal and Industrial Institute, under the control of the Board of Trustees of the Institute.

STATION STAFF.

George W. Carver, M. S. Agr., *Dir.*
George R. Bridgeforth, B. S., *Dir. Agr. Indus.*
R. A. Clark, *Asst. to Dir. Agr. Indus.*
T. N. Cowan, *Farm Supt.*
E. F. Colson, *First Asst. to Farm Supt.*
J. P. Powell, *Second Asst. to Farm Supt.*
H. H. Wheeler, *Dairy Herdsman.*
R. S. Pompey, *Asst. to Dairy Herdsman.*
C. W. Greene, *Truck Garden.*
A. A. Turner, *Dairyman.*
A. L. Evans, *Poultry Raising.*
W. A. Tate, *in charge of Swine Herd.*
M. Van Darthard, *in charge Horses and Mules.*
R. R. Robinson, *Asst. in charge Horses and Mules.*
Thos. M. Campbell, *Demonstrative and Farmers' Inst. Work.*
R. L. Waggener, *Farm Mech.*
E. L. Falkner, *Fruit Growing.*
L. J. Watkins, *Road Building and Construction Work.*
John E. Shaw, *Vet.*
F. C. Jones, *U. S. Demonstration Work.*

ALASKA.

Alaska Agricultural Experiment Stations, *Sitka, Copper Center, Rampart, Fairbanks, and Kodiak.*

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

C. C. Georgeson, M. S., *Special Agent in Charge, Sitka.*
R. W. De Armond, *Asst. at Sitka.*
G. W. Gasser, B. S., *Asst. at Rampart.*
M. D. Snodgrass, B. S., *Asst. at Kodiak.*
Laurence Kelly, *Asst. Dairyman at Kodiak.*
J. W. Neal, *Asst. at Fairbanks.*

ARIZONA.

University of Arizona, *Tucson.*

GOVERNING BOARD.

Board of Regents: M. P. Freeman (*Chancellor*), *Tucson;* Geo. J. Roskruge (*Sec.*), *Tucson;* Chas. H. Bayless (*Treas.*), *Tucson;* A. V. Grossetta, *Tucson;* Gov. Richard E. Sloan (*ex officio*), *Phoenix;* K. T. Moore (*Supt. of Public Instr., ex officio*), *Phoenix.*

COURSES OF STUDY.

The university offers six regular four-year courses of study leading to a degree, viz: Literary, scientific, metallurgy, mining engineering, civil engineering, and mechanical engineering; also a two-year agricultural and a four-year preparatory course.

BOARD OF INSTRUCTION.

Kendric C. Babcock, PH. D., *President; History, Political Economy.*

Ernest S. Bates, PH. D., *Engl.*
F. N. Guild, M. A., *Chem.*
John J. Thornber, B. S., A. M., *Biol.*
W. W. Henley, A. B., *Mech. Arts.*
R. W. Clothier, M. S., *Agr.; in charge of Farmers' Insts.*
Chas. A. Turrell, M. A., *Mod. Lang.*
Hiram McL. Powell, Capt., U. S. A., *Mil. Sci. and Tactics.*
A. E. Douglass, A. B., Sc. D., *Phys., Astron.*
L. A. Waterbury, C. E., *Civil Engin.*
W. G. Medcraft, A. M., *(Asst.) Math.*
R. C. Benner, PH. D., *(Asst.) Chem.*
H. A. E. Chandler, B. S., *(Asst.) Econ. and Hist.*
Estelle G. Lutrell, B. A., *Instr. Engl.; Libr.*
Caroline B. Singleton, A. B., *Instr. Engl.*
Ida C. Reid, B. S., PH. B., *Instr. Hist., Math.*
F. L. Kleeberger, B. S., *Instr. Phys. Training, Math.*
E. W. Waldron, B. A., *Instr. Engl.*
Helen Aldrich, PH. D., *Instr. Mod. Lang.*
Elizabeth E. Roberts, A. B., *Instr. German.*
W. L. Fowler, B. S., *Instr. Animal Husb.*
John Isaacson, *Instr. Shop Pract.*
James G. Brown, *Instr. Bot.*

Agricultural Experiment Station of the University of Arizona, *Tucson.*

Department of the University of Arizona, under the control of the Board of Regents.

STATION STAFF.

R. H. Forbes, M. S., *Dir.; Chem.*
J. J. Thornber, A. M., *Bot.*
A. E. Vinson, PH. D., *Biochem.*
F. W. Wilson, B. S., *(Phoenix), Assoc. Animal Husb.*
G. E. P. Smith, C. E., *Irrig. Engin.*
W. B. McCallum, PH. D., *Assoc. Bot.*
Geo. F. Freeman, B. S., *Plant Breeding.*
W. H. Ross, PH. D., *Asst. Chem.*
R. W. Clothier, M. S., *Agr.; in charge of Dry Land Invest.*
F. C. Kelton, B. S., *Asst. Engin.*
A. W. Morrill, PH. D., *(Phoenix), Ent.*
E. D. Trout, *Sec.*

ARKANSAS.

College of Agriculture of the University of Arkansas, *Fayetteville.*

GOVERNING BOARD.

Board of Trustees: Gov. Geo. W. Donaghey* *(ex officio Pres.), Little Rock;* Geo. B. Cook *(State Supt. of Public Instr., ex officio), Little Rock;* John E. Neelly *(Sec.), Fayetteville;* D. M. Allen *(Treas.), Fayetteville;* G. T. Breckinridge,* *Paragould;* John F. Rutherford, *Pine Bluff;* W. S. Goodwin,* *Warren;* M. L. Davis, *Dardanelle;* F. P. Hall,* *Fayetteville;* Gustave Jones,* *Newport;* R. O. Herbert, *Greenwood.*

COURSES OF STUDY.

The College of Agriculture offers a four-year course leading to the degree of B. S. A., a two-year course leading to a certificate, and a three weeks' winter course for farmers. Graduate work leading to the master's degree is also given.

BOARD OF INSTRUCTION.

John N. Tillman, LL. D., *President of the University.*

C. F. Adams, B. AGR., A. M., M. D., *Dean of College of Agr.; Ent.*
R. R. Dinwiddie, V. S., M. D., *Consulting Animal Husb. and Path.*
Ernest Walker, B. S. A., *Hort.*
F. W. Pickel, PH. D., *Biol.*
V. A. Hooper, *Dairy Husb.*
C. G. Carroll, PH. D., *Chem.*
E. F. Shannon,[a] *Engl.*
O. D. Wanamaker, PH. D., *(Actg.) Engl.*
Wilfrid Lenton, V. S., *Vet. Sci.*
Rufus J. Nelson, M. S., *Agr. Ed.*
W. M. Bruce, PH. D., *Agr. Chem.*
Martin Nelson, B. S. A., M. S., *Agron.*
J. Lee Hewitt, B. S. A., *Plant Path.*
H. E. Morrow, B. S. A., *(Assoc.) Chem.*

[a] On leave.

Geo. A. Cole, B. S., M. A., *Supt. of Farmers' Insts.*
A. K. Short, B. S. A., (*Actg.*) *Animal Husb.*
Carl H. Tourgee, B. S. Agr., (*Adjunct*) *Dairy Husb.*
W. S. Jacobs, B. S. A., (*Adjunct*) *Agron.*
H. D. Young, B. S., (*Adjunct*) *Agr. Chem.*
Robt. D. Carter, Lieut., U. S. A., *Mil. Sci. and Tactics; Comdt.*
Garland Greever, A. M., (*Adjunct*) *Engl. and Mod. Lang.*
Mrs. E. M. Blake, *Instr. Engl.*
Jobelle Holcomb, M. A., *Instr. Engl. and Mod. Lang.; Matron of Women.*
J. W. Wilson, B. S. A., (*Adjunct*) *Agr. Ed.*
R. M. Gow, D. V. M., (*Adjunct*) *Vet. Sci.*
Mrs. Mary Austin, *Libr.*
F. J. George, *Asst. Libr.*

Arkansas Agricultural Experiment Station, *Fayetteville.*

Department of the University of Arkansas, under the control of the Board of Trustees.

STATION STAFF.

Charles F. Adams, B. Agr., A. M., M. D., *Dir.; Ent.*
R. R. Dinwiddie, V. S., M. D., *Consulting Path. and Bact.*
Ernest Walker, B. S. A., *Hort.*
Victor A. Hooper, *Dairying.*
Wilfrid Lenton, V. S., *Vet.*
W. M. Bruce, Ph. D., *Chem.*
Martin Nelson, B. S. A., M. S., *Agron.*
J. L. Hewitt, B. S. A., *Plant Path.*
A. K. Short, B. S. A., *Animal Husb.*
W. S. Jacobs, B. S. A., *Asst. Agr.*
C. H. Tourgee, B. S. Agr., *Asst. Dairy Husb.*
H. D. Young, B. S., *Asst. Chem.*
J. F. Stanford, M. D. V., *Asst. Animal Path.*
Paul Hayhurst, A. B., *Asst. Ent.*
Ashleigh P. Boles, M. A., *Asst. Plant Path.*
J. R. Tucker, B. S. A., *Asst. Agr. Chem.*
M. B. Oates, B. S. A., *Asst. Animal Husb.*
R. M. Gow, D. M. V., *Asst. in Vet. Sci.*
C. A. Ruzek, B. S., *Asst. Agron.*
L. L. Wootton, B. A. *Executive Clerk, Libr.*

CALIFORNIA.

College of Agriculture of the University of California, *Berkeley.*

GOVERNING BOARD.

The Regents of the University: Gov. J. N. Gillett (*ex officio Pres.*), *Sacramento;* W. R. Porter * (*Lieut.-Gov.*), *Watsonville;* Philip H. Stanton (*Speaker of the Assembly*), *202 Union Trust Building, Los Angeles;* Edward Hyatt (*State Supt. of Public Instr.*), *Sacramento;* Henry A. Jastro * (*Pres. State Agr. Society*), *1704 19th st., Bakersfield;* R. J. Taussig, *Main and Mission sts., San Francisco;* Benjamin Ide Wheeler (*Pres. of Univ.*), *1820 Scenic ave., Berkeley;* Isaias W. Hellman, *Wells-Fargo Nevada National Bank, San Francisco;* Chester Rowell, *Fresno;* Wm. H. Crocker, *Crocker National Bank, San Francisco;* C. W. Slack,* *504 Kohl Building, San Francisco;* J. B. Reinstein, *836 Mills Building, San Francisco;* J. E. Budd, *Stockton;* Mrs. Phoebe A. Hearst, *354 Pine st., San Francisco;* A. W. Foster, *1210 James Flood Building, San Francisco;* Garret W. McEnerney, *1277 James Flood Building, San Francisco;* Frank S. Johnson,* *210 California st., San Francisco;* G. C. Earl,* *1005 Shreve Building, San Francisco;* J. W. McKinley, *Pacific Electric Building, Los Angeles;* Rev. P. C. Yorke, *1267 Sixteenth ave., Oakland;* J. A. Britton, *445 Sutter st., San Francisco;* F. W. Dohrmann, *201 Geary st., San Francisco;* Thos. R. Bard, *Hueneme;* Victor H. Henderson (*Sec.*), *Berkeley.*

COURSES OF STUDY.

The university comprises several departments. The college of agriculture has a four-year general and a four-year technical course in agriculture, each leading to the degree of B. S.; short courses in agriculture covering from two to eight weeks each; a six weeks' summer school for teachers, and a farmers' week.

BOARD OF INSTRUCTION.[a]

Benjamin Ide Wheeler, Ph. D., LL. D., *President of the University.*

Edward J. Wickson, M. A., *Dean of Agr.; Agr.*
Eugene W. Hilgard, Ph. D., LL. D., *Agr., Emeritus.*
Wm. A. Setchell, Ph. D., *Bot.*
Leroy Anderson, M. S. A., Ph. D., *Agr. Pract.; Supt. Univ. Farm School.*
Meyer E. Jaffa, M. S., *Nutrition.*

[a] Includes only instructors in subjects *directly relating to agriculture.* Other members of the university may give instruction to students pursuing the agricultural course.

Robt. H. Loughridge, Ph. D., *Agr. Chem., Emeritus.*
Chas. W. Woodworth, M. S., *(Assoc.) Ent.*
George W. Shaw, Ph. D., *Expt. Agron., (Assoc.) Agr. Tech.*
Ralph E. Smith, B. S., *(Assoc.), Plant Path.*
E. W. Major, B. Agr., *(Davis), Mgr. Univ. Farm; (Assoc.) Animal Indus.*
F. T. Bioletti, M. S., *(Assoc.) Vit.*
Ralph S. Minor, Ph. D., *(Assoc.) Phys.*
Archibald R. Ward, B. S. A., D. V. M., *(Asst.) Vet. Sci., Bact.*
J. H. Norton, B. Agr., M. S., *(Asst.) Agr. Chem.*
H. J. Quayle, A. B., *(Asst.) Ent.*
Wm. B. Herms, B. S., M. A., *(Asst.) Ent.*
Clarence M. Haring, D. V. M., *(Asst.) Vet. Sci.*
Harvey M. Hall, Ph. D., *(Asst.) Bot.*
Bernard A. Etcheverry, B. S., *(Asst.) Irrig. Engin.*
W. T. Clarke, B. S., *(Asst.) Hort.; Supt. of Farmers' Insts. and Univ. Ext. in Agr.*
H. A. Hopper, B. S. A., *(Asst.) Dairy Husb.*
E. B. Babcock, B. S., *(Asst.) Agr. Ed.*
John S. Burd, B. S., *(Asst.) Agr. Chem.*
H. J. Ramsey, M. S., M. A., *(Asst.) Plant Path.*
Wm. T. Horne, B. S., *(Asst.) Plant Path.*
John E. Coit, Ph. D., *(Whittier), (Asst.) Pomol.*
Robert E. Mansell, *Instr. Hort.*
Ralph Benton, B. S., B. L., *Instr. Ent.*
Emil H. Hagemann, *Instr. Dairying.*
E. J. Lea, M. S., *Instr. Agr. Chem.*
D. R. Hoagland, A. B., *Instr. Agr. Chem.*
Arthur W. Cleghorn, A. B., *(Davis), Prin. Univ. Farm School; Instr. Engl., Math.*
R. M. Roberts, B. S. A., *(Davis), Instr. Farm Pract.*
Roscoe Farrar, B. S., *Instr. Soils and Farm Crops.*
Charles B. Lipman, M. S., *Instr. Soil Bact.*
Howard Phillips, B. S., *(Davis), Instr. Animal Indus.*
F. D. Hawk, B. S. A., *(Davis), Instr. Animal Indus.*
A. J. Gaumnitz, M. S. A., *(Davis), Asst. in Agron.*
Fred L. Yeaw, B. S., *Asst. in Plant Path.*
Thomas F. Hunt, B. S., *Asst. in Plant Path.*
Elizabeth H. Smith, M. S., *Asst. in Plant Path.*
Mattie E. Stover, *Asst. in Agr. Lab.*
Hans C. Holm, B. S., *Asst. in Zymological Tech.*
N. D. Ingham, *Asst. in Sylviculture.*
L. Bonnet, *Asst. in Vit.*
Earl L. Morris, B. S., *Field Asst. in Ent.*
W. H. Volck, *Field Asst. in Ent.*
J. S. Hunter, *Field Asst. in Ent.*
Frank E. Johnson, B. L., B. S., *Asst. in Soil Lab.*
P. L. Hibbard, B. S., *Asst. in Fert. Control.*
P. L. McCreary, B. S., *Asst. in Fert. Control.*

Agricultural Experiment Station of the University of California, *Berkeley.*

Department of the University of California, under the control of the Regents of the University.

STATION STAFF.

E. J. Wickson, A. M., *Dir.; Hort.*
E. W. Hilgard, Ph. D., LL. D., *Chem.*
W. A. Setchell, Ph. D., *Bot.*
Elwood Mead,[a] C. E., D. E., *Irrig. Engin.*
Leroy Anderson, M. S. A., Ph. D., *Dairy Indus.; Supt. of Univ. Farm School.*
M. E. Jaffa, M. S., *Nutrition Expert; in charge of Poultry Sta.*
C. W. Woodworth, M. S., *Ent.*
R. H. Loughridge, Ph. D., *Soil Chem. and Soil Phys.*
G. W. Shaw, Ph. D., *Tech. Agr.; in charge of Cereal Sta.*
Geo. E. Colby, M. S., *Chem. (Fruits, Waters, Insecticides); in charge of Chem. Lab.*
R. E. Smith, B. S., *Plant Path.; in charge of Southern California Path. Lab. and Expt. Sta.*
A. R. Ward,[a] B. S. A., D. V. M., *Vet., Bact.*
F. T. Bioletti, M. S., *Vit.*
E. W. Major, B. Agr., *(Davis), Animal Indus.; Farm Mgr., Univ. Farm.*
H. M. Hall, Ph. D., *Asst. Bot.*
H. J. Quayle, A. B., *(Whittier), Asst. Ent.*
J. E. Coit, Ph. D., *(Whittier), Asst. Hort. in charge Citrus Invest.*
W. T. Clarke, B. S., *Asst. Hort.; Supt. Univ. Ext. in Agr.*
J. S. Burd, B. S., *Chem. in Charge of Fert. Control.*
C. M. Haring, D. V. M., *Asst. Vet. and Bact.*
H. A. Hopper, M. S. A., *(Davis), Asst. Dairy Husb.*
J. H. Norton, M. S., *(Riverside), Asst. Chem. in charge of Fert. Expts.*
W. B. Herms, B. S., M. A., *Asst. Ent.*
T. F. Hunt, B. S., *(Riverside), Asst. Hort.*
Elizabeth H. Smith, A. B., M. S., *Asst. Plant Path.*
F. L. Yeaw, B. S., *(Vacaville), Asst. Plant Path.*
C. O. Smith, M. S., *(Whittier), Asst. Plant Path.*
E. B. Babcock, B. S., *Asst. Agr. Ed.*
W. T. Horne, B. S., *Asst. Plant Path.*
R. E. Mansell, *Asst. Hort.; in charge of Central Sta. Grounds.*
Ralph Benton, B. L., B. S., *Asst. Ent.*
E. H. Hagemann, *(Davis), Asst. in Dairying.*
E. J. Lea, M. S., *Asst. Agr. Chem.*
A. J. Gaumnitz, M. S. A., *(Davis), Asst. in Cereal Invest.*
J. S. Rose, B. S., *Asst. in Cereal Lab.*

[a] On leave.

H. C. Holm, B. S., *Asst. in Zymology.*
P. L. McCreary, B. S., *Asst. in Fert. Control Lab.*
F. E. Johnson, B. L., *Asst. in Soil Lab.*
Mattie E. Stover, B. S., *Asst. in Agr. Chem. Lab.*
D. R. Hoagland, A. B., *Asst. in Agr. Chem. Lab.*
Charles Fuchs, *Curator Ent. Museum.*
C. B. Lipman, M. S., *Asst. in Soil Bact.*
P. L. Hibbard, B. S., (*Haywards*), *Asst. in Fert. Control Lab.*
R. M. Roberts, B. S. A., (*Davis*), *Field Asst. in Vit., Univ. Farm.*
Roscoe Farrar, B. S., (*Davis*), *Asst. in Soils and Farm Crops, Univ. Farm.*
B. S. Brown, B. S. A., (*Davis*), *Asst. in Hort., Univ. Farm.*
Howard Phillips, B. S., (*Davis*), *Asst. in Animal Indus., Univ. Farm.*
L. M. Davis, B. S., (*Davis*), *Asst. in Dairy Husb., Univ. Farm.*
N. D. Ingham, (*Santa Monica*), *Asst. in Sylviculture.*
L. Bonnet, *Asst. in Vit.*
S. S. Rogers, (*Whittier*), *Asst. Plant Path.*
W. H. Volck, (*Watsonville*), *Field Asst. in Ent.*
Earl L. Morris, B. S., (*San José*), *Field Asst. in Ent.*
J. S. Hunter, (*San Mateo*), *Field Asst. in Ent.*

COLORADO.

The State Agricultural College of Colorado, *Fort Collins.*

GOVERNING BOARD.

The State Board of Agriculture: A. A. Edwards * (*Pres.*), *Fort Collins;* J. L. Brush * (*V. Pres.*), *Greeley;* L. M. Taylor (*Sec.*), *Fort Collins;* G. A. Webb (*Treas.*), *Fort Collins;* E. H. Grubb, *Carbondale;* B. F. Rockafellow, *Canon City;* R. W. Corwin, *Pueblo;* F. E. Brooks, *Colorado Springs;* E. M. Ammons,* *Littleton;* J. C. Bell, *Montrose;* Gov. John F. Shaforth (*ex officio*), *Denver;* Chas. A. Lory (*ex officio*), *Fort Collins.*

COURSES OF STUDY.

There are eight four-year courses, viz: Agricultural, horticultural, forestry, mechanical engineering, irrigation and civil engineering, electrical engineering, general and domestic science, and the course in general science for women (B. S.); postgraduate courses; three-year course in veterinary science (D. V. S.); three-year course of six months each in agriculture and domestic science, to which may be added a fourth year of nine months for college entrance; two-year course in mechanic arts; one-year courses in bookkeeping and farriery, and short winter courses in practical agriculture and domestic science. Theoretical and practical courses in library science and library economy are also offered.

BOARD OF INSTRUCTION.

Charles A. Lory, M. S., LL. D., *President.*

James W. Lawrence, M. E., *Dean of Faculty; Mech. Engin.*
Louis G. Carpenter, M. S., *Civil and Irrig. Engin.*
Clarence P. Gillette, M. S., *Zool., Ent.*
Geo. H. Glover, M. S., D. V. M., *Vet. Sci.*
William P. Headden, Ph. D., *Chem., Geol.*
Mary F. Rausch, *Dom. Sci.*
Edward B. House, M. S., E. E., (*Assoc.*), *Irrig. Engin.*
L. M. Taylor, *Sec. of the Faculty.*
Virginia H. Corbett, B. L., M. Ph., *Hist., Lit.*
William R. Thomas, M. A., Litt. D., *Constitutional Hist. and Irrig. Law.*
Benjamin F. Coen, B. L., *Engl.*
Sarah I. Kettle, A. B., *Mod. Lang.*
Harry D. Humphrey, Capt., U. S. A. (Retired), *Mil. Sci. and Tactics.*
Alvin Keyser, B. S., M. A., *Agron.*
H. M. Cottrell, M. S., *Dir. Farmers' Inst.; Ext. Work.*
G. E. Morton, B. S. A., *Animal Husb.*
Clarence L. Barnes, D. V. M., *Vet. Sci., Surgery.*
B. F. Kaupp, B. S., D. V. S., *Vet. Sci., Path.*
H. M. Bainer, M. S. A., *Farm Mech.; Instr. Dairying.*
E. R. Bennett, B. S., *Hort., For.*
Burton O. Longyear, B. S., *Bot., For.*
Walter G. Sackett, B. S., *Bact.*
Robert E. Trimble, B. S., *Met., Irrig. Engin.*
Frederick A. DeLay, B. S., *Phys., Elect. Engin.*
Leslie F. Paull, A. M., Ph. B., (*Assoc.*) *Hort.*
S. L. Macdonald, B. A. *Math.*
Frederick C. Alford, M. S., (*Assoc.*) *Chem.*
S. Arthur Johnson, M. S., (*Assoc.*) *Ent., Zool.*
I. E. Newsom, B. S., D. V. S., (*Assoc.*) *Vet. Sci.*
H. E. Kingman, D. V. S., (*Assoc.*) *Vet. Sci.*
Charles Golding-Dwyre, jr., B. Acct., *Farm Accts.*
T. M. Netherton, A. M., *Prin. School of Agr.*
Joseph F. Daniels, *Libr. Sci.; Libr.*
Inga M. K. Allison, E. B., *Instr. Dom. Sci.*
E. Bessey, B. S., E. E., *Instr. Elect. Engin.*

Zula M. Brockett, B. A., *Instr. Engl.*
H. B. Bonebright, B. S. A., *Asst. in Farm Mech.*
Rebecca R. Boswell, *Instr. Dom. Art.*
L. C. Bragg, *Curator of Museum.*
Albert Cammack, M. E., *Instr. Mech. Engin.*
Earl Douglass, M. S., *Asst. in Chem.*
D. W. Frear, B. S., *Asst. in Agr.*
Marguerite Frink, Ped. B., B. A., *Asst. in Math.*
Geo. P. Weldon, B. S. (*Grand Junction*), *Zool. Field Agt.*
Robert S. Herrick, B. S. (*Delta*), *Hort. Field Agt.*
Laura Chatfield, *Asst. in Mod. Lang.*
E. J. Iddings, B. S., *Asst. in Animal Husb.*
Fred N. Langridge, M. E., *Asst. in Mech. Engin.*
D. E. Mackey, M. E., *Asst. in Forge and Foundry.*
Ralph Parshall, B. S., *Asst. in Civil and Irrig. Engin.*
James Pennycook, *Instr. Horseshoeing.*
Fred G. Person, B. A., *Asst. in Phys., Elect. Engin.*
Hiram Pierce, *Instr. Carpentry.*
C. E. Vail, B. S., M. A., *Asst. Chem.*
W. E. Vaplon, *Poultryman.*

Agricultural Experiment Station, *Fort Collins.*

Department of the State Agricultural College of Colorado, under the control of the State Board of Agriculture.

STATION STAFF.

L. G. Carpenter, M. S., *Dir.; Met., Irrig. Engin.*
C. P. Gillette, M. S., *Ent.*
W. P. Headden, Ph. D., *Chem.*
B. O. Longyear, B. S., *Bot., For.*
G. H. Glover, M. S., D. V. M., *Vet.*
Alvin Keyser, B. S., M. A., *Agron.*
W. G. Sackett, B. S., *Bact.*
E. R. Bennett, B. S., *Hort.*
L. M. Taylor, *Sec.*
F. C. Alford, M. S., *Asst. Chem.*
Earl Douglass, M. S., *Asst. Chem.*
R. E. Trimble, B. S., *Asst. Met., Irrig. Engin.*
S. Arthur Johnson, M. S., *Asst. Ent.*
Miriam A. Palmer, A. M., *Sta. Illustrator.*
L. C. Bragg, *Asst. Field Ent.*
H. M. Bainer, M. S. A., *Farm Mach.*
Philo K. Blinn, B. S., *Field Agt., Arkansas Valley Substa., Rockyford.*
Geo. P. Weldon, B. S., (*Grand Junction*), *Field Ent.*
R. S. Herrick, B. S., (*Delta*), *Field Hort.*
C. L. Fitch, *Field Asst.* (*Potato Invest.*).

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

GOVERNING BOARD.

State Board of Control: Gov. Frank B. Weeks (*ex officio Pres.*), *Hartford;* W. H. Brewer (*Sec.*), *New Haven;* H. W. Conn, *Middletown;* G. A. Hopson, *Wallingford;* F. H. Stadtmueller, *Elmwood;* C. M. Jarvis, *Berlin;* E. H. Jenkins (*Treas.*), *New Haven;* J. H. Webb, *Box 1425, New Haven.*

STATION STAFF.

Edward H. Jenkins, Ph. D., *Dir.*
John P. Street, M. S., *Chief Chem.*
T. B. Osborne, Ph. D., *Chem.*
E. Monroe Bailey, Ph. B., *1st Asst. Chem.*
Clifford B. Morrison, *Chem.*
Clarence E. Shepard, *Chem.*
Ralph B. Roe, A. B., *Asst. Chem.*
Wilton E. Britton, Ph. D., *Ent.; State Ent.*
B. H. Walden, B. Agr., *Asst. Ent.*
George P. Clinton, S. D., *Bot.*
Samuel N. Spring, A. B., M. F., *in charge of Forest Work and State For.*
Walter O. Filley, *Asst. For.*
V. E. Cole, *Libr., Clerk.*
Hugo Lange, *Lab. Asst.*
J. B. Olcott, *Grass Gard.* (*South Manchester*).
V. L. Churchill, *Sampling Agt.*

The Connecticut Agricultural College, *Storrs.*[a]

GOVERNING BOARD.

Board of Trustees: Gov. Frank B. Weeks (*ex officio Pres.*), *Hartford;* E. H. Jenkins, *New Haven;* G. A. Hopson, *Wallingford;* E. S. Henry, *Rockville;* D. W. Patten[a] (*Treas.*), *Clintonville;* C. A. Capen,[a] (*Sec.*), *Willimantic;* A. J. Pierpont, *Waterbury;* L. J. Storrs,[a] *Mansfield Center;* H. G. Manchester,[a] (*V. Pres.*), *Winsted;* C. M. Jarvis, *New Britain;* J. W. Alsop, *Avon.*

[a] Telegraph address, *Storrs* via *Willimantic;* railroad station, express, and freight address, *Eagleville.*

COURSES OF STUDY.

Two years of preparatory academic work. Three three-year courses (diploma upon graduation), open to those who have completed the two preparatory years or their equivalent, as follows: Agriculture (dairying and poultry culture, and horticulture), mechanic arts, and home economics. The B. S. degree is given for one additional year of work in agriculture.

Summer school of about four weeks, for teachers and others, in nature study and agriculture. Two twelve weeks' winter courses in dairying and pomology; a six weeks' poultry course and a six weeks' course in forestry.

BOARD OF INSTRUCTION.

Charles L. Beach, B. AGR., B. S., *President.*

Louis A. Clinton, M. S., *Agron.*
Alfred G. Gulley, M. S., *Hort.*
John M. Trueman, B. S. A., *Dairy Husb.*
Chas. A. Wheeler, M. A., *Math.*
Henry R. Monteith, B. A., *Hist., Engl.*
Edwin O. Smith, B. S., *Engl., Polit. Econ.; Sec. of Faculty.*
Albert F. Blakeslee, PH. D., *Bot.*
Alberta T. Thomas, *Dom. Sci., Lady Prin.*
Wm. M. Esten, M. S., *Bact.*
Frederic H. Stoneburn, *Poultry Husb.*
George H. Lamson, jr., B. AGR., M. S., *Geol., Ent.*
H. D. Newton, PH. D., *Instr. Chem., Phys.*
John N. Fitts, B. AGR., *Mech. Arts.*
Edwina M. Whitney, PH. B., *Instr. German; Libr.*
Orpha C. Smith, *Instr. Elocution, Engl.*
Herman D. Edmond, B. S., *Instr. Mil. Sci.*
Harry L. Garrigus, B. AGR., *Instr. Animal Husb.; Farm Supt.*
Alva T. Stevens, M. S., *Instr. Hort.*
Wm. M. Wilson, *Instr. Greenhouse Work.*
Chas. F. Stephenson, *Asst. Poultryman.*
Elizabeth Donovan, *Asst. in Chem., Phys.*
Abby M. Hicks, *Instr. Music.*
Edward B. Fitts, *Asst. in Dairying.*
Bert K. Dow, *Lect. in Vet. Sci.*

Storrs Agricultural Experiment Station, *Storrs.*[a]

Department of the Connecticut Agricultural College, under the control of the Board of Trustees.

STATION STAFF.

L. A. Clinton, M. S., *Dir.*
J. M. Trueman, B. S. A., *Dairy Husb.*
F. H. Stoneburn, *Poultryman.*
Wm. M. Esten, M. S., *Dairy Bact.*
C. D. Jarvis, B. S. A., PH. D., *Hort.*
Geo. H. Lamson, jr., B. AGR., M. S., *Ent.*
H. D. Edmond, B. S., *Chem.*
Chas. Thom,[b] PH. D., *Cheese Expert, Myc.*
A. W. Dox,[b] PH. D., *Cheese Expert, Chem.*
Clinton Grant,[b] *Cheese Maker.*
Christie J. Mason, B. AGR., *Asst. Bact.*
Grace E. Seage, *Asst. Bact.*

DELAWARE.

Delaware College, *Newark.*

GOVERNING BOARD.

Board of Trustees: C. B. Lore (*Pres.*), *Wilmington;* Manlove Hayes * (*V. Pres.*), *Dover;* C. B. Evans (*Sec. and Treas.*), *Newark;* Gov. S. S. Pennewill (*ex officio*), *Dover;* Preston Lea, *Wilmington;* G. A. Harter * (*ex officio*), *Newark;* H. G. M. Kollock, *Newark;* J. C. Higgins, *Delaware City;* G. W. Marshall, *Milford;* J. H. Whiteman, *Wilmington;* George Biddle, *Elkton;* F. W. Curtis, *Wilmington;* W. T. Lynam, *Wilmington;* D. W. Corbit,* *Odessa;* Edward Reynolds, *Middletown;* L. H. Ball, *Marshallton;* L. P. Bush, *Wilmington;* J. C. Stockly, *Smyrna;* James Pennewill, *Dover;* C. S. Conwell, *Camden;* Geo. G. Kerr,* *Newark;* J. E. Dutton, *Seaford;* E. R. Paynter, *Georgetown;* W. H. Stevens, *Seaford;* John Biggs, *Wilmington;* W. Watson Harrington, *Dover;* Lewis W. Mustard, *Lewes;* S. H. Messick,* *Bridgeville;* S. H. Derby,* *Woodside;* Thomas Davis, *Wilmington;* J. H. Hossinger, *Newark.*

[a] Telegraph address, *Storrs* via *Willimantic;* railroad station, express, and freight address, *Eagleville.*

[b] In the service of the U. S. Department of Agriculture.

COURSES OF STUDY.

There are seven regular four-year courses, viz: Classical and Latin scientific (B. A.), agricultural (B. S. in Agr.), and general science (B. S.), and three engineering courses (B. S. in civil, mechanical, or electrical engineering); four-year agricultural (no degree), a two-year course and a one week's winter course in agriculture.

BOARD OF INSTRUCTION.

Geo. A. Harter, M. A., Ph. D., *President; Mathematics and Physics.*

Edgar S. Stayer, Lieut., U. S. A., *Mil. Sci. and Tactics; Comdt.*
Harry Hayward, M. S. Agr., *Animal Husb.; Dean Dept. Agr.*
W. Owen Sypherd, M. A., Ph. D., *Engl., Polit. Sci.*
Clarence A. Short, M. S., *Math.*
Chas. F. Dawson, M. D., D. V. S., *Bact.*
Chas. A. McCue, B. S., *Hort.*
Arthur E. Grantham, B. A., B. S. A., *Agron.*
Charles L. Penny, M. A., *Agr. Chem.*
Clinton O. Houghton, B. A., *Zool., Bot.*
Harold E. Tiffany, M. S., *Instr. Chem.*
Joseph M. McVey, B. A., *Instr. Math.*
Ezra K. Maxfield, M. A., *Instr. Engl.*

The Delaware College Agricultural Experiment Station, *Newark.*

Department of Delaware College, under the control of the Board of Trustees.

STATION STAFF.

Harry Hayward, M. S. Agr., *Dir.*
C. F. Dawson, M. D., D. V. S., *Vet.*
C. A. McCue, B. S., *Hort.*
M. T. Cook, Ph. D., *Plant Path.*
A. E. Grantham, B. A., B. S. A., *Agron.*
Firman Thompson, B. S., *Chem.*
Herman D. Eggers, jr., *Asst. Chem.*
Jacob Taubenhaus, *Asst. Plant Path.*
H. R. Post, *Farm Foreman.*
Lottie W. Baker, *Sec.*

State College for Colored Students, *Dover.*

GOVERNING BOARD.

Board of Trustees: C. B. Lore (*Pres.*), *Wilmington;* Walter Morris (*Sec. and Treas.*), *Dover;* G. W. Marshall, *Milford;* Ebe W. Tunnell, *Lewes;* H. P. Cannon, *Bridgeville;* W. C. Jason (*ex officio*), *Dover;* F. H. Hoffecker, *Wilmington.*

COURSES OF STUDY.

The following four-year courses, leading to the degrees of B. S., B. Agr., and B. E., respectively, are offered: Scientific, agricultural, and engineering. There is also a three-year normal course, and industrial courses of two years each in woodworking, iron working, blacksmithing, masonry, printing, cooking, sewing, and dressmaking.

BOARD OF INSTRUCTION.

Rev. William C. Jason, A. M., D. D., *President; Latin, Psychology, Civics.*

Samuel L. Cornwell, A. M., *Ancient and Mod. Hist., Bot.; Sec.*
Lydia P. Laws, *Engl. Lit., U. S. Hist., Dom. Sci.*
T. W. Gordy, *Phys., Chem., Physiol.*
J. R. Cogbill, *Supt. Indus. Dept.; Math.*
Cecil Elsie Parker, B. S., *Arith., Grammar, Engl. Composition, Libr.*
Everett L. Brown, *Instr. Woodwork, Mech. Draw., Geog., Spelling.*
G. Winfield Deputy, *Instr. Pract. Agr.*

FLORIDA.

University of the State of Florida, *Gainesville.*

GOVERNING BOARD.

Board of Control: P. K. Yonge* (*Chair.*), *Pensacola;* T. B. King,* *Arcadia;* E. L. Wartmann,* *Citra;* F. P. Fleming,* *Jacksonville;* W. D. Finlayson,* *Old Town;* J. G. Kellum (*Sec.*), *Tallahassee.*

COURSES OF STUDY.

The work of the university is divided into six departments or schools, offering the following courses: Literary (B. A.), general science (B. S.), agricultural (B. S. in Agr.), three in engineering (B. S. in M. E., B. S. in E. E., and B. S. in C. E.), pedagogical (B. A. in Ped.), and law (LL. B.). Two-year courses in agriculture, mechanic arts, and pedagogy, leading to certificates, one-year preparatory, a six weeks' summer school for teachers and a correspondence course for teachers and farmers are also offered.

BOARD OF INSTRUCTION.

A. A. Murphree, A. M., LL. D., *President of the University.*

Jas. M. Farr, Ph. D., *V. Pres.; Engl.*
John A. Thackston, Ph. D., *Philos., Ed.*
Edward R. Flint, Ph. D., M. D., *Chem.*
J. R. Benton, Ph. D., *Phys.*
C. L. Crow, Ph. D., *Mod. Lang.*
Jas. N. Anderson, Ph. D., *Lat., Greek.*
Enoch M. Banks, Ph. D., *Hist., Econ.*
H. S. Davis, Ph. D., *Zool., Geol.*
Geo. M. Lynch, A. B., *Secondary Ed.*
John J. Vernon, M. S. A., *Agr., Hort.*
H. G. Keppel, Ph. D., *Math., Astron.*
E. S. Walker, Major, U. S. A. (Retired), *Comdt.; Mil. Sci.*
N. H. Cox, B. S., *Civil Engin.*
W. L. Floyd, M. S., *Biol.*
K. H. Graham, *Auditor, Bookkeeper.*
G. E. Pile, *Phys. Dir.*
M. B. Hadley, A. B., *Libr.*

Agricultural Experiment Station of Florida, *Gainesville.*

Department of the University of the State of Florida, under the control of the Board of Control.

STATION STAFF.

P. H. Rolfs, M. S., *Dir.; in charge of Farmers' Insts.*
A. W. Blair, A. M., *Chem.*
John M. Scott, B. S., *Animal Indus.*
E. W. Berger, Ph. D., *Ent.*
H. S. Fawcett, M. S., *Plant Path.*
B. F. Floyd, A. M., *Plant Physiol.*
Stanley E. Collison, M. S., *Asst. Chem.*
R. Y. Winters,[a] M. S., *Asst. Bot.*
John Belling, B. S., *Asst. Hort.*
B. B. Ezell, B. S., *Asst. Plant Physiol.*
Owen F. Burger, A. B., *Asst. Plant Path.*
J. C. Macmillan, *Asst. Ent.*
M. Crews, *Farm Foreman.*
K. H. Graham, *Auditor, Bookkeeper.*
Mrs. E. W. Berger, *Libr.*

Florida Agricultural and Mechanical College for Negroes, *Tallahassee.*

GOVERNING BOARD.

State Board of Education: Gov. Albert W. Gilchrist (*Pres.*), *Tallahassee;* W. M. Holloway (*Sec.*), *Tallahassee;* H. C. Crawford, *Tallahassee;* W. V. Knott, (*Treas.*), *Tallahassee;* W. H. Ellis, *Tallahassee.*

Board of Control: P. K. Yonge (*Chair.*), *Pensacola;* F. P. Flemming, *Jacksonville;* E. L. Wartmann, *Citra;* T. B. King, *Arcadia;* W. D. Finlayson, *Old Town;* J. G. Kellum (*Sec.*), *Tallahassee.*

COURSES OF STUDY.

The courses of study are: Four-year scientific (B. S.), normal (two years), high school and grammar school (three years each), with industrial training through all courses.

BOARD OF INSTRUCTION.

Nathan B. Young, M. A., *President; Ed., Econ.*

Geo. M. Sampson, M. A., *Sec.; Dir. Acad. Dept.; Math., Lat.*
Evalina A. Davis, *Cooking.*
W. A. Armwood, *Carpentry, Mech. Draw.*
Everett B. Jones, B. S., *Chem. Biol., Sci.*
F. H. Cardozo, *Dir. Agr. Dept.; Agr. Sci., Hort.*
W. H. Crutcher, *Farm Supt.; Pract. Agr.*
D. A. Sparks, *Animal Husb.*
Miss J. V. Hilyer, *Nurse Training.*
Daisy E. Attaway, *Engl.*
Mary E. Melvin, *Dean of Women; Engl. and Amer. Hist.*
Hattie E. Newbern, B. Ped., *Engl., Sew.*

[a] On leave.

Ellen O. Paige, *Dressmaking.*
Eliza J. Powell, *Engl.*
Lulu M. Cropper, *Engl.; Registrar, Libr.*
E. Edna Jenkins, *Millinery.*
Julian L. Brown, *Print.*
James N. English, A. B., *(Asst.) Sci.*
Jessie V. Stephens, A. B., *Instr. German and Engl.*
Julia O. Wright, A. B., *Instr. Typew. and Sten.*
F. C. Johnson, B. S., *Dir. and Auditor; Phys., Instr. Mech. Draw.*
A. E. Martin, *Tailoring.*
W. H. A. Howard, M. A., *Comdt., (Asst.) Math., Instr. Painting.*
T. S. Johnson, *Wheelwr., Blacksm.*

GEORGIA.

Georgia State College of Agriculture, University of Georgia, *Athens.*

Trustees: J. J. Conner *(Pres.), Cartersville;* J. W. Bennett, *Waycross;* J. T. Newton, *Madison;* D. M. Hughes, *Danville;* L. G. Hardman,* *Commerce;* T. G. Hudson,* *Atlanta;* R. C. Neely,* *Waynesboro;* J. L. Hand, *Pelham;* L. H. O. Martin, *Middleton;* A. J. McMullan, *Hartwell;* J. A. Trash, *Greenville;* A. L. Hull *(Sec. and Treas.), Athens.*

COURSES OF STUDY.

Four courses in agriculture are offered, viz. a four-year course leading to the degree of B. S., one-year course, three months' course, a ten days' cotton school, and a farmers' week.

BOARD OF INSTRUCTION.

David C. Barrow, C. and M. E., *Chancellor of the University.*

Andrew M. Soule, B. S. A., *Pres. of the College; Dir. State Farmers' Insts.*
H. C. White, Ph. D., D. C. L., LL. D., *Chem.*
L. L. Hendren, Ph. D., *Phys., Astron.*
John Morris, A. M., *German, Engl.*
Wm. D. Hooper, A. M., *Lat.*
Robt. E. Park, A. M., *Engl.*
Chas. M. Strahan, C. and M. E., *Civil Engin.*
John P. Campbell, Ph. D., *Biol.*
J. H. T. McPherson, Ph. D., *Hist., Polit. Sci.*
Chas. M. Snelling, A. M., *Math.*
John R. Fain, B. S., *Expt. Agron.*
J. M. Reade, B. S. A., Ph. D., *Bot.*
Milton P. Jarnagin, B. S. A., *Animal Husb.*
R. P. Stephens, A. B., Ph. D., *(Adjunct) Math.*
H. V. Black, Ph. D., *(Adjunct) Chem.*
Ernest L. Griggs, *(Adjunct) Civil Engin.*
Steadman V. Sanford, A. B., *(Junior) Engl.*
R. J. H. De Loach, A. M., *Cotton Industry.*
J. S. Stewart, A. M., *Secondary Ed.*
Joseph Lustrat, M. A., *Romance Lang.*
Thos. J. Woofter, A. M., Ph. D., *Philos., Ed.*
Thos. H. McHatton, D. Sc., *(Adjunct) Hort.*
Alfred Akerman, A. B., M. F., *For.*
Wm. O. Payne, M. A., *Instr. Hist., Polit. Sci.*
F. D. Posey, A. B., *Instr. Math.*
R. L. McWhorter, A. M., *Instr. Lat.*
Leroy C. Hart, B. S., E. E., *Farm Mech.*
M. D. Du Bose, A. M., *Instr. Engl., German.*
S. M. Salyer, A. B., *Instr. Engl.*
R. P. Brooks, B. A., *(Adjunct) Georgia Hist.*
P. O. Vanatter, *Supt. Field Demonstrations.*
J. H. Burnett, *Libr.*
Jas. M. Kimbrough, Lieut., U. S. A., *Comdt.*

Georgia Experiment Station, *Experiment.*[a]

Department of Georgia State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Directors: Thomas G. Hudson *(Pres.), Atlanta;* J. B. Park *(Sec. and Treas.), Greensboro;* David C. Barrow, *Athens;* A. M. Soule, *Athens;* R. C. Neely, *Waynesboro;* R. F. Crittenden, *Shellman;* J. T. Ferguson, *De Soto;* J. H. Mobley, *Hamilton;* E. L. Peek, *Conyers;* N. B. Drewry, *Griffin;* Felix Corput, *Cave Spring;* L. G. Hardman, *Commerce;* George Gilmore, *Warthen;* William Henderson, *Ocilla.*

STATION STAFF.

Martin V. Calvin, *Dir.*
J. M. Kimbrough, *Asst. Dir.; Agr.*
H. C. White, Ph. D., D. C. L., LL. D., *(Athens), V. Dir.; Chem.*
Paul N. Flint, M. S., *Animal Husb.*
H. P. Stuckey, B. S. A., *Hort.*
C. A. McLendon, B. S., *Bot., Plant Path.*
J. C. Temple, B. Agr., M. S., *Bact.*
J. C. McClain, B. S., *Dairy Ext. Work.*
J. E. Dorman, *Dairy Field Agt.*

[a] Telegraph, freight, and express address, *Griffin.*

Georgia State Industrial College, University of Georgia, *Savannah.*

GOVERNING BOARD.

Board of Commissioners: P. W. Meldrim (*Chair.*), *Savannah;* W. R. Hammond, *Atlanta;* P. J. Cline, *Milledgeville;* Otis Ashmore, *Savannah;* Geo. T. Murrell, *Athens;* D. C. Barrow (*Chancellor Univ. of Georgia, ex officio*), *Athens;* J. F. Brooks (*Treas.*), *Savannah.*

COURSES OF STUDY.

The courses offered are industrial, preparatory, normal, and collegiate. Practical agriculture is made one of the industrial features of the college courses. A special dairy course covering two months is offered during the winter.

BOARD OF INSTRUCTION.

David C. Barrow, C. and M. E., *Chancellor of the University.*

R. R. Wright, A. M., LL. D., *Pres. of the College; Instr. Engl. and Mental and Moral Sci.*
D. C. Suggs, Ph. D., *V. Pres.; Instr. Nat. Sci.*
J. G. Lemon, A. M., *Instr. Math.*
S. A. Grant, A. B., *Instr. Engl. Pedag.*
Henry Pearson, A. M., *Asst. Instr. Engl.; Sec. of Faculty.*
L. B. Thompson, A. B., *Supt. Mech. Dept.; Asst. Instr. Math., Masonry, Plastering.*
W. C. McLester, *Foreman of Farm.*
J. M. Roston, *Wheelwr.; Proctor.*
Mrs. W. C. McLester, *Sew.*
J. H. Hazel, *Painting, Glazing, Sign Writing, Calcimining.*
R. M. Cooper, *Tailoring.*
Mrs. D. E. Pearson, *Prin. of Model School.*
G. A. Holloway, *Shoe and Harness Making.*
J. W. Warren, *Blacksm.*
E. M. Wilson, *Carpentry, Mech. Draw.*

GUAM.

Guam Agricultural Experiment Station.[a]

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

John B. Thompson, B. S., *Special Agent in Charge.*
H. L. V. Costenoble, *Assistant.*

HAWAII.

College of Hawaii, *Honolulu.*

GOVERNING BOARD.

H. E. Cooper, A. Gartley, Morris J. Bissel, Walter G. Smith, Ralph S. Hosmer.

COURSES OF STUDY.

The college offers four courses leading to the degree of B. S., as follows: Scientific, agricultural, household economics, and engineering. In addition, courses for special students and correspondence courses are provided.

BOARD OF INSTRUCTION.

John W. Gilmore, M. S. A., *President; Agronomy.*

W. T. Pope, B. S., *Bot., Hort.*
J. S. Donaghho, B. A., *Math.*
John M. Young, M. M. E., *Mech. Engin.*
Wm. A. Bryan, B. S., *Zool.*
A. R. Keller, C. E., *Civil Engin.*
F. T. Dillingham, S. B., *Chem.*
B. E. Porter, B. S. A., *Animal Hush.*
Val Buehner, A. B., *German, French.*
Agnes Hunt, B. S., *Dom. Econ.*
Minnie E. Chipman, *Ceramics.*
Raymond C. Severance, B. S., *Phys., Chem.*
Mildred M. Yoder, Ph. B., *Engl.*

[a] Address: *Island of Guam,* via *San Francisco.*

Hawaii Agricultural Experiment Station, ***Honolulu.***

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

E. V. Wilcox, PH. D., *Special Agent in Charge.*
J. Edgar Higgins, B. A., M. S. A., *Hort.*
F. G. Krauss, *Agron.*
W. P. Kelley, M. S., *Chem.*
D. T. Fullaway, A. B., *Ent.*
Alice R. Thompson, B. S., *Asst. Chem.*
C. J. Hunn, B. S. A., *Asst. Hort.*
Q. Q. Bradford, *Asst. in Rubber Invest.*
Valentine Holt, *Asst. Agron.*

Hawaiian Sugar Planters' Experiment Station, ***Honolulu.***

GOVERNING BOARD.

STATION STAFF.

C. F. Eckart, M. S., *Dir.*
R. C. L. Perkins, B. A., Sc. D., *Ent.*
Noel Deerr, *Sugar Tech.*
Harold L. Lyon, PH. D., *Path.*
Samuel S. Peck, B. S., PH. G., *Chem.*
R. S. Norris, PH. D., *1st Asst. Chem.*
F. R. Werthmueller, B. S., *Asst. Chem.*
Arthur E. Jordan, *Asst. Chem.*
E. G. Clarke, *Agr.*
D. C. Broderick, *Field Foreman.*
J. H. Wale, *Substa. Asst.*
A. Koebele, *Consulting Ent.*
George W. Kirkaldy, *Asst. Ent.*
Frank W. Terry, *Asst. Ent.*
O. H. Swezey, B. A., M. S., *Asst. Ent.*
F. W. Muir, *Asst. Ent.*
L. D. Larsen, *Asst. Path.*
W. R. Potter, *Illustrator, Sta. Publications.*

IDAHO.

College of Agriculture of the University of Idaho, ***Moscow.***

GOVERNING BOARD.

COURSES OF STUDY.

The regular course in agriculture requires four years for its completion and leads to the degree of B. S. A four-year preparatory course, a three-year course in agriculture and horticulture, a one-year course in commercial dairying, a special winter course of from four to six weeks in general farm practice, dairying, and horticulture, and a short winter course for forest rangers are also offered.

BOARD OF INSTRUCTION.

James A. MacLean, PH. D., LL. D., *President of the University; Political Economy.*

Edwin E. Elliott, M. S., *Dean of the College; Agr. Ed.*
John M. Aldrich, PH. D., *Biol.*
J. Shirley Jones, B. S., *Agr. Chem.*
J. H. Frandson, M. S. A., *Dairying.*
Elias Nelson, M. A., (*Caldwell*), *Irrig.*
C. H. Shattuck, PH. D., *For.*
William H. Wicks, M. S. A., *Hort.*
L. F. Childers, M. S., *Agron.*
John F. Nicholson, M. S., *Bact.*
F. W. Chamberlain, D. V. M., *Vet. Sci., Animal Husb.*
Jay G. Eldridge, PH. D., *German.*
Carl von Ende, PH. D., *Chem.*
Edward M. Hulme, A. M., *Hist.*
Charles N. Little, PH. D., *Civil Engin.*
Wm. S. Morley, A. M., Sc. D., *Math.*
Henrietta E. Moore, PH. D., *Engl. Lit.*
Lawrence E. Gurney, PH. D., *Phys.*
Miss B. S. Maynard, *Instr. Dom. Sci.*
Mrs. Jennie L. K. Haner, *Instr. Dom. Art. Draw.*
O. M. Osborne, *Instr. Agr.*
Andrew W. Smith, Lieut., U. S. A., *Mil. Sci. and Tactics; Comdt. of Cadets.*
C. C. Tull, *Instr. Engl. Lang.*
Belle Sweet, B. L. S., *Libr.*
Eber D. Kanaga, M. D., *Phys. Ed.*
Miss Permeal French, *Dean of Women.*

Agricultural Experiment Station of the University of Idaho, *Moscow.*

Department of the University of Idaho, under the control of the Board of Regents.

STATION STAFF.

W. L. Carlyle, M. S., *Dir.; in charge of Farmers' Institutes.*
J. Shirley Jones, B. S., *Chem.*
J. H. Frandson, M. S. A., *Dairying.*
W. H. Wicks, M. S. A., *Hort.*
Elias Nelson, M. A., *(Caldwell), Irrig.*
L. F. Childers, M. S., *Agron.*
J. F. Nicholson, M. S., *Bact.*
H. P. Fishburn, M. A., *Asst. Chem.*
C. W. Colver, B. S., *Asst. Chem.*
G. E. Frevert, B. S. A., *Asst. in Dairying.*
Prentice Moore, *Farm Foreman.*

ILLINOIS.

College of Agriculture of the University of Illinois, *Urbana.*

GOVERNING BOARD.

Board of Trustees of the University: Gov. Chas. S. Deneen *(ex officio), Springfield;* G. H. Madden *(Pres. State Bd. of Agr., ex officio), Mendota;* F. G. Blair *(State Supt. of Public Instr., ex officio), Springfield;* Mrs. Carrie T. Alexander, *Belleville;* Lewis L. Lehman, *Mattoon;* Laura B. Evans, *Taylorville;* William L. Abbott *(Pres.), 139 Adams street, Chicago;* Charles Davison, *1010, 103 State street, Chicago;* Mrs. Mary E. Busey, *Urbana;* F. L. Hatch, *Spring Grove;* William L. Pillsbury *(Sec.), Urbana;* H. A. Haugan *(Treas.), State Bank of Chicago, Chicago;* S. W. Shattuck *(Comptroller), Champaign;* Eugene Funk, *Bloomington.*

COURSES OF STUDY.

Three four-year courses, leading to the degree of B. S., viz: Agriculture, household science, and landscape gardening, and six weeks' summer courses in secondary and elementary agriculture for rural teachers, and two-week courses in agriculture and domestic science, are offered. Provision is also made for special students.

BOARD OF INSTRUCTION.

Edmund J. James, Ph. D., LL. D., *President of the University.*

Eugene Davenport, M. Agr., LL. D., *Dean; Thremmatology.*
Thomas J. Burrill, Ph. D., LL. D., *V. Pres.; Bot.*
Henry B. Ward, Ph. D., *Zool.*
Charles W. Rolfe, M. S., *Geol.*
Donald McIntosh, V. S., *Vet. Sci.*
Samuel W. Parr, M. S., *Applied Chem.*
Daniel K. Dodge, Ph. D., *Engl., Lit.*
David Kinley, Ph. D., *Econ.; Dean of Graduate School.*
Albert P. Carman, Sc. D., *Phys.*
Evarts B. Greene, Ph. D., *Hist.*
Geo. A. Huff, *Dir. Phys. Training.*
Geo. H. Meyer, M. A., *(Asst.) German.*
Thomas A. Clark, B. L., *Rhet.*
Thomas E. Oliver, Ph. D., *Romance Lang.*
Isabel Bevier, Ph. M., *Household Sci.*
Cyril G. Hopkins, Ph. D., *Agron.*
Edmond G. Fechét, Lieut. Col., U. S. A. (Retired), *Mil. Sci.*
Herbert W. Mumford, B. S., *Animal Husb.*
Harry S. Grindley, Sc. D., *Chief in Animal Chem.*
Philip B. Hawk, Ph. D., *Physiol. Chem.*
Chas. F. Hottes, Ph. D., *(Asst.) Bot.*
Frank Smith, B. Ph., A. M., *(Assoc.) Zool.*
Joseph C. Blair, M. S. A., *Pomol.*
Wilber J. Fraser, M. S., *Dairy Husb.*
Neil C. Brooks,[a] Ph. D., *(Asst.) German.*
John W. Lloyd, M. S. A., *(Asst.) Oler.*
Louie H. Smith, Ph. D., *(Asst.) Plant Breeding.*
Ward J. MacNeal, Ph. D., M. D., *(Asst.) Bot.*
Justus W. Folsom, Sc. D., *(Asst.) Ent.*
Daisy L. Blaisdell, A. M., *Instr. German.*
W. C. Coffey, B. S., *Assoc. in Sheep Husb.*
Daniel O. Barto, A. B., B. S., *Instr. Agr. for Secondary Schools.*
Chas. S. Crandall, M. S., *(Assoc.) Pomol.*
J. G. Mosier, B. S., *(Asst.) Soil Phys.*
Jas. H. Pettit, Ph. B., *(Asst.) Soil Fertility.*
William Dietrich, M. S. A., *(Asst.) Swine Husb.*
Louis D. Hall, M. S., *(Asst.) Animal Husb.*
Cassius C. Hayden, B. S. A., *(Asst.) Dairy Husb.*
Rufus C. Obrecht, B. S. A., M. S., *Assoc. in Horse Husb.*
Frank W. Scott, A. M., *(Assoc.) Engl.*
Earl A. White, B. S., *Asst. in Agr. Mech.*
Ira W. Dickerson, B. S., *Asst. in Agr. Mech.*
K. J. T. Ekblaw, B. S., *Asst. in Agr. Mech.*
Herman B. Dorner, M. S., *Instr. Flor.*
Albert N. Hume,[a] M. S., *Assoc. in Crop Production.*

[a] On leave.

O. D. Center, B. S., *Assoc. in Crop Production.*
William G. Eckhardt, B. S., *Asst. in Soil Fertility.*
Chas. F. Briscoe, A. M., *Instr. Bot.*
Fred. H. Rankin, *Supt. Agr. College Ext.*
F. L. Charles, M. S., *(Asst.) Agr. Ed.*
Susannah Usher, S. B., *(Asst.) Household Sci.*
Anna Van Meter, M. S., *(Asst.) Household Sci.*
A. Phelps Wyman, B. S. Agr., *(Asst.) Landscape Gard.*
H. F. Major, B. S., LL. B., *Asst. in Landscape Gard.*
R. B. Howe, B. S., *Instr. Pomol.*
Charlotte M. Gibbs, A. M., *Instr. Textiles.*
Leonard Hegnauer, A. B., B. S. Agr., *Instr. Crop Production, Asst. in College Ext.*
Harry O. Allison, B. S., *Instr. Animal Husb.*
Walter L. Gaines, B. S., *Instr. Dairy Husb.*
A. F. Gustafson, B. S., *Asst. in Soil Phys.*
Nelson W. Hepburn, B. S., *Asst. in Dairy Manufactures.*
Helena M. Pincomb, B. S., *Asst. in Household Sci.*
Nellie E. Goldthwaite, Ph. D., *Research Asst. in Household Sci.*
Arthur Lumbrick, B. S., *Asst. in Crop Production.*
R. E. Brand, B. S., *Asst. in Dairy Husb.*

Agricultural Experiment Station of the University of Illinois, *Urbana.*

Department of the University of Illinois, under the control of the Board of Trustees.

STATION STAFF.

Eugene Davenport, M. Agr., LL. D., *Dir.*
C. G. Hopkins, Ph. D., *V. Dir.; Chief in Agron.*
Stephen A. Forbes, Ph. D., *Consulting Ent.*
L. H. Smith, Ph. D., *Asst. Chief in Chem. and Plant Breeding.*
J. G. Mosier, B. S., *Asst. Chief in Soil Phys.*
J. H. Pettit, Ph. B., *Asst. Chief in Soil Fertility.*
A. F. Gustafson, B. S., *Asst. in Soil Phys.*
W. G. Eckhardt, B. S., *Asst. in Soil Fertility.*
A. N. Hume,[a] M. S., *Asst. Chief in Crop Production.*
O. D. Center, B. S., *First Asst. in Crop Production.*
Leonard Hegnauer, A. B., B. S. Agr., *Asst. in Crop Production.*
J. E. Readhimer, B. S., *Supt. of Soil Expt. Fields.*
J. P. Aumer, B. S., *Asst. in Chem.*
Arthur Lumbrick, B. S., *Asst. in Crop Production.*
O. S. Fisher, B. S., *Asst. in Soil Fertility.*
C. C. Logan, B. S., *Asst. in Soil Phys.*
J. B. Park, A. B., *Asst. in Chem.*
Ernest Van Alstine, B. S., *Asst. in Chem.*
Clyde H. Myers, B. S., *Asst. in Chem.*
H. W. Mumford, B. S., *Chief in Animal Husb.*
H. S. Grindley, Sc. D., *Chief in Animal Chem.*
W. J. MacNeal, Ph. D., M. D., *Asst. Chief in Bact.*
F. W. Gill, B. S., *First Analyst in Animal Nutrition.*
Arthur D. Emmett, B. S., M. A., *Assoc. in Animal Nutrition.*
S. V. Holt, B. S., *Asst. in Soil Survey.*
A. W. Hayes, B. S., *Asst. in Soil Survey.*
H. W. Stewart, B. S., *Asst. in Soil Survey.*
H. C. Wheeler, *Asst. in Soil Survey.*
Gertrude Niederman, B. S., *Asst. Chem.*
R. G. Smith, B. S., *Asst. Chem.*
William Dietrich, M. S. A., *Asst. Chief in Swine Husb.*
L. D. Hall, M. S., *Asst. Chief in Animal Husb.*
R. C. Obrecht, B. S. A., M. S., *Assoc. in Horse Husb.*
W. C. Coffey, M. S., *First Asst. in Sheep Husb.*
H. O. Allison, B. S., *Asst. in Animal Husb.*
Donald McIntosh, V. S., *Consulting Vet.*
W. J. Fraser, M. S., *Chief in Dairy Husb.*
N. W. Hepburn, B. S., *Asst. in Dairy Manufactures.*
C. C. Hayden, M. S. A., *Asst. in Dairy Husb.*
Jesse M. Barnhart, B. S., *Asst. Chem. in Dairy Husb.*
R. E. Brand, B. S., *Asst. in Dairy Husb.*
Walter L. Gaines, B. S., *Asst. in Dairy Husb.*
D. L. James, B. S., *Asst. in Dairy Husb.*
LeRoy Lang, B. S., *Asst. in Dairy Husb.*
J. C. Blair, M. S. A., *Chief in Hort.*
O. S. Watkins, B. S., *Asst. Chem. in Hort.*
C. S. Crandall, M. S., *Chief in Plant Breeding.*
John W. Lloyd, M. S. A., *Asst. Chief in Olcr.*
R. B. Howe, B. S., *Field Asst. in Pomol.*
I. S. Brooks, B. S., *Asst. in Pomol.*
T. J. Burrill, Ph. D., LL. D., *Bot.*
H. B. Dorner, M. S., *Asst. in Flor.*
A. H. Nehrling, *Asst. in Flor.*
E. W. Bailey, M. S., *Asst. in Plant Breeding.*
W. A. Ruth, M. S., *Asst. Hort. Chem.*
C. E. Durst, B. S., *Asst. in Olcr.*
Henry L. Rietz, Ph. D., *Statistician.*
Catherine M. McIntire, *Sec.*

[a] On leave.

INDIANA.

School of Agriculture of Purdue University, *Lafayette*.

GOVERNING BOARD.

COURSES OF STUDY.

The course of study requires four years for completion and leads to the degree of B. S. in agriculture. There are also short winter courses in agriculture and horticulture, dairying, animal husbandry, and household economics, and a farmers' week.

BOARD OF INSTRUCTION.[a]

Winthrop Ellsworth Stone, PH. D., LL. D., *President of the University*.

John H. Skinner, B. S., *Dean; Animal Husbandry*.
William C. Latta, M. S., *Agr.; Supt. of Farmers' Insts.*
James Troop, M. S., *Hort., Ent.*
Robert A. Craig, D. V. M., *Vet. Sci.*
Albert T. Wiancko, B. S. A., *Agron.*
Otto F. Hunziker, M. S. A., *Dairy Husb.*
Stanley Coulter, PH. D., LL. D., *Biol.*
J. C. Arthur, D. Sc., *Veg. Physiol. and Path.*
Percy N. Evans, PH. D., *Chem.*
Ervin S. Ferry, B. S., *Phys.*
Emma M. McRae, M. A., *Engl. Lit.*
Thos. F. Moran, PH. D., *Hist., Polit. Econ.*
Herman Babson, PH. D., *German.*
Pauline Mariotte-Davies, PH. D., *French.*
Alfred M. Kenyon, A. M., *Math.*
Thos. G. Alford, A. M., *Math.*
Erastus Test, M. S., M. D., *Math.*
George L. Roberts, A. B., *Indus. Ed.*
Benjamin H. Watkins, Capt., U. S. A., *Mil. Sci. and Tactics; Comdt. of Cadets.*
James H. Ransom, PH. D., *Gen. Chem.*
Mrs. Henrietta W. Calvin, B. S., *Household Econ.*
Alpha P. Jamison, M. E., *Mech. Draw.*
George I. Christie, B. S. A., *Agr. Ext.*
Severance Burrage, S. B., (*Assoc.*) *Sanitary Sci.*
Carolyn E. Shoemaker, M. S., (*Assoc.*) *Engl.*
E. G. Mahin, PH. D., (*Assoc.*) *Chem.*
Edward H. Davis, S. B., (*Assoc.*) *Econ.*
W. McE. Nye, B. S., (*Asst.*) *Farm Mech.*
Wm. W. Smith, B. S. A., (*Asst.*) *Animal Husb.*
Martin L. Fisher, B. S., (*Asst.*) *Agron.*
Charles M. Smith, B. S., (*Asst.*) *Phys.*
Ralph B. Trueblood, B. S., (*Asst.*) *Pract. Mech.*
A. R. Middleton, PH. D., (*Asst.*) *Chem.*
John Heiss, A. M., (*Asst.*) *German.*
Chas. H. Beckett, A. B., (*Asst.*) *Math.*
Howard E. Enders, PH. D., *Instr. Zool.*
Oliver P. Terry, M. S., M. D., *Instr. Physiol.*
S. D. Conner, M. S., *Instr. Agr. Chem.*
J. D. Jarvis, B. S. A., *Instr. Dairying.*
O. E. Reed, B. S. A., *Instr. Milk Production.*
Clare N. Arnett, B. S., *Instr. Animal Husb.*
Otis Crane, *Instr. Poultry Husb.*
Jesse G. Boyle, B. S., *Asst. in Hort.*
C. E. Craig, M. S. A., *Asst. in Agron.*
Wm. M. Hepburn, A. M., *Libr.*

Agricultural Experiment Station of Indiana, *Lafayette*.

Department of Purdue University, under the control of the Board of Trustees.

STATION STAFF.

Arthur Goss, M. S., A. C., *Dir.; Chem.*
James Troop, M. S., *Hort. Ent.*
J. C. Arthur, D. Sc., *Bot.*
J. H. Skinner, B. S., *Chief Animal Husb. Dept.*
A. T. Wiancko, B. S. A., *Agr.*
R. A. Craig, D. V. M., *Vet.*
O. F. Hunziker, M. S. A., *Chief Dairy Husb. Dept.*
W. J. Jones, jr., M. S., A. C., *State Chem.*
G. I. Christie, B. S. A., *Supt. Agr. Ext.*
G. W. Spitzer, PH. G., *Dairy Chem.*
M. L. Fisher, B. S., *Assoc. Agr.*
S. D. Conner, M. S., *Assoc. State Chem.*
F. D. Kern, M. S., *Assoc. Bot.*
C. G. Woodbury, M. S., *Assoc. Hort.*
J. B. Abbott, M. S. A., *Asst. in Soil Improvement.*
H. P. Rusk, B. S. A., *Asst. Animal Husb.*
C. O. Cromer, B. S., *Asst. Agr.*

[a] This list does not include the instructors exclusively engaged in the schools of engineering, science, and pharmacy.

G. M. Frier, B. S. A., *Asst. in Ext. Work.*
A. G. Johnson, B. S., *Asst. Bot.*
B. R. Ryall, M. S., *Asst. Hort.*
H. H. Madans, B. S., *Asst. Vet.*
H. E. Kiger, B. S. A., *Asst. Animal Husb.*
H. C. Mills, B. S., *Asst. Dairy Husb.*
O. E. Reed, B. S. A., *Asst. in Milk Production.*
P. H. Crane, B. S., *Asst. in Dairy Field Work.*
W. F. Epple, Ph. D., *Asst. Dairy Chem.*
O. C. Haworth, B. S., *Chief Deputy State Chem. (Fert. and Feed-Stuff Control).*
E. G. Proulx, B. S., *Asst. State Chem. (Fert. Control).*
C. W. Rice, B. S., *Asst. State Chem. (Fert. Control).*
Carleton Cutler, B. S., *Asst. State Chem. (Feed-Stuff Control).*
A. G. Summers, B. S., *Asst. State Chem. (Feed-Stuff Control).*
W. F. Fisher, *Insp. (Fert. and Feed Control).*
O. S. Roberts, B. S., *Insp. (Fert. and Feed Control).*
Thomas Billings, *Asst. in Plant Culture.*
W. P. Lane, *Foreman in Hort. Dept.*
L. S. Mills, *Foreman in Agr. Dept.*
C. F. Benson, *Helper in Vet. Dept.*
Henry Wagner, *Helper (Feed-Stuff Control).*
John Wagner, *Helper (Fert. Control).*
E. A. Ellsworth, *Sec.*
Nellie Tracy, *Clerk and Libr.*

IOWA.

Iowa State College of Agriculture and Mechanic Arts, *Ames.*

GOVERNING BOARD.

Board of Education: Gov. B. F. Carroll (*ex officio*), *Des Moines;* J. F. Riggs (*Supt. of Public Instr., ex officio*), *Des Moines;* A. B. Funk, *Spirit Lake;* J. E. Trewin, *Cedar Rapids;* P. K. Holbrook, *Onawa;* Roger Leavitt, *Cedar Falls;* C. R. Brenton, *Dallas Center;* T. D. Foster, *Ottumwa;* E. T. Schoentgen, *Council Bluffs;* D. D. Murphy, *Elkader;* G. T. Baker, *Davenport;* Herman Knapp (*Treas.*), *Ames.*

COURSES OF STUDY.

The courses of study are fourteen, each requiring four years for completion, with optional five-year courses in the division of engineering, leading to advanced degrees. The six courses in agriculture (agronomy, dairying, animal husbandry, horticulture and forestry, agricultural engineering, and science and agriculture) lead to the degree of B. S. A.; the course in veterinary science, to the degree of D. V. M.; the course in mechanical engineering, to the degree of B. M. E.; the course in civil engineering, to the degree of B. C. E.; the course in electrical engineering, to the degree of B. S. in E. E.; the course in mining engineering, to the degree of B. S. in Min. E.; the course in ceramics, to the degree of B. E. M. in Cer.; the course in science as related to the industries, to the degree of B. S., and the course in domestic science for women, to the degree of B. D. S. There are also two-year courses in mining and clay working, one-year courses in dairying and poultry husbandry, a one-year preparatory course, short winter courses in stock, corn, and grain judging, dairying, horticulture and forestry, agricultural engineering, poultry, and domestic science, and a course in agricultural journalism.

BOARD OF INSTRUCTION.

Rev. Albert Boynton Storms, A. M., D. D., LL. D., *President; Dean of the Division of Science.*

Edgar W. Stanton, M. S., LL. D., *Dean of the Junior College; Math.*
Charles F. Curtiss, M. S. A., D. Sc., *Dean Div. Agr.*
Hon. James Wilson, M. S. A., *Lect. in Agr.*
Gen. James R. Lincoln, *Mil. Sci.*
Alfred A. Bennett, M. S., *Chem.*
Louis H. Pammel, B. Agr., M. S., Ph. D., *Bot., Gen. Bact.*
Fletcher Briggs, Ph. B., A. M., *Mod. Lang.*
Louis B. Spinney, B. M. E., M. S., *Phys., Illuminating Engin.*
Alvin B. Noble, B. Ph., *Rhet., Lit.*
Chas. H. Stange, D. V. M., *Dean Div. of Vet. Med.; Vet. Med., Surgery.*
Henry E. Summers, B. S., *Zool.*
Robert E. Buchanan, M. S., *Gen. Bact.*
R. R. Dykstra, D. V. M., *Anat., Obstetrics.*
Charles A. Scott, B. S. A., (*Assoc.*) *For.*
Martin Mortensen, B. S. A., (*Assoc.*) *Dairying; Actg. Head of Dairy Dept.*
Orange H. Cessna, A. M., D. D., *Hist., Psych.*
Willard J. Kennedy, B. S. A., *Animal Husb.*
Arthur MacMurray, B. A., M. O., *Public Speaking.*

Sybil Lentner, B. S., (*Asst.*) *Public Speaking.*
Wm. H. Stevenson, A. B., B. S. A., *Soils.*
J. Brownlee Davidson, B. S. in M. E., *Agr. Engin.*
Spencer A. Beach, B. S. A., M. S., *V. Dean Div. Agr.; Hort.*
Benjamin H. Hibbard, B. Agr., Ph. D., *Econ., Polit. Sci.*
Mrs. Alice Dynes-Feuling, B. S., *Dom. Econ.*
Maria M. Roberts, B. L., (*Assoc.*) *Math.; V. Dean of Junior College.*
Arthur T. Erwin, B. S., M. S. A., (*Assoc.*) *Hort.*
Lola A. Placeway, B. S., (*Assoc.*) *Chem.*
Winfred F. Coover, A. M., (*Assoc.*) *Chem.*
Wayne Dinsmore, B. S. A., (*Assoc.*) *Animal Husb.*
W. W. Dimock, D. V. M., (*Assoc.*) *Vet. Med. and Research.*
Wm. H. Pew, B. S. A., (*Asst.*) *Animal Husb.*
Vina E. Clark, *Libr.*
Herman Knapp, B. S. A., *Registrar.*
Elizabeth Maclean, M. Di., (*Assoc.*) *Engl.*
Joseph E. Guthrie, M. S., (*Asst.*) *Zool.*
Ernest A. Pattengill, B. S., (*Asst.*) *Math.*
Julia Colpitts, A. M., (*Asst.*) *Math.*
Louis B. Schmidt, A. M., (*Asst.*) *Hist.*
A. H. Hoffman, A. M., B. S. in E. E., (*Asst.*) *Phys.*
W. B. Anderson, M. S., Ph. D., (*Asst.*) *Phys.*
Lulu Graves, B. Ed. (*Asst.*) *Dom. Econ.*
G. T. Guthrie, B. S. A., (*Asst.*) *Dairying.*
H. S. Murphy, D. V. M., (*Asst.*) *Vet. Med.*
H. E. Bemis, B. S., D. V. M., (*Asst.*) *Vet. Med., Surgery.*
Julia R. Vaulx, A. M., (*Asst.*) *Engl.*
Dora G. Tompkins, A. M., (*Asst.*) *Engl.*
J. E. Brindley, A. M., (*Asst.*) *Econ. Sci.*
Harry G. Bell, B. S. A., (*Asst.*) *Farm Crops.*
B. W. Crossley, B. S. A., (*Asst.*) *Farm Crops.*
Ira G. McBeth, M. S. A., (*Asst.*) *Soil Bact.*
Alexander S. Thompson, *Dir. of Music; Piano, Pipe Organ, Voice.*
Mrs. Clara D. Thompson, *V. Dir. of Music; Instr. Voice, Piano, Organ.*
Louise Peters, A. M., *Instr. German, Spanish.*
W. R. Raymond, B. A., *Instr. Engl.*
Laura Taggart, B. S., *Instr. Chem.*
Orin L. Kipp, B. S., *Instr. Chem.*
C. E. Bartholomew, M. S., *Instr. Ent.*
Ethyl Cessna, B. S., *Instr. Hist.*
M. W. Pullen, B. S. in E. E., *Instr. Phys.*
Mabel Campbell, B. S., *Instr. Dom. Econ.*
Agnes G. Mosher, B. S., *Instr. Math.*
George R. MacMinn, A. B., *Instr. Engl.*
Ingeborg Lommen, A. B., M. L., *Instr. German.*
Lola Stephens, B. S., *Instr. Chem.*
C. V. Gregory, *Instr. Agr. Journalism.*
Roger S. Mackintosh, B. Agr., *Instr. Hort.*
A. N. Chadsey, *Instr. Dairying.*
Anna Fleming, B. S., *Instr. Math.*
Grace I. Norton, B. A., *Instr. German.*
Ward M. Jones, B. C. E., *Instr. Math.*
Marie Zimmerman, A. B., *Instr. German.*
Mrs. Mary P. Fairfield, A. B., *Instr. French.*
Mrs. Daisy A. Arville, A. B., *Instr. Spanish, French.*
Mary M. Morris, Ph. B., *Instr. Engl.*
Winifred Tilden, B. A., *Dir. Phys. Culture.*
Estelle D. Fogel, B. A., M. S., *Instr. Bot.*
Carrie Watters, B. A., *Instr. Hist.*
E. W. Hamilton, B. S. A., *Instr. Agr. Engin.*
F. L. Odell, *Instr. Dairying.*
Joseph F. Barker, M. S. A., *Instr. Soils.*
William Kunerth, A. B., *Instr. Phys.*
Helen F. Smith, A. B., *Instr. Math.*
Frederica V. Shattuck, A. B., *Instr. Public Speaking.*
Ruth B. Safford, B. L., *Instr. Engl.*
E. N. Wentworth, M. S. A., *Instr. Animal Husb.*
Chas. L. Mundhenk, *Dir. Band; Instr. Brass Instruments.*
Harriette Kellogg, A. M., *Curator of Herbarium.*
George Mitchell, *Farm Foreman.*
W. A. Lippincott, A. B., *Poultryman.*
C. O. Alexander, B. M. E., *Instr. Agr. Engin.*
Roy E. Smith, B. S. A., *Instr. Soils.*
E. V. Griggs, B. M. E., B. S. in E. E., *Instr. Math.*
Francis W. Dickey, M. A., *Instr. Econ. and Polit. Sci.*
Lelia Purdy, *Instr. Dom. Econ.*
Archibald Leitch, B. S. A., *Asst. in Animal Husb.; Supt. of Dairy Farm.*
J. H. Gordon, B. S. A., *Asst. in Dairy Bact.*
Florence A. Armstrong, Ph. B., *Asst. in Engl.*
Jesse McKeen, B. S., *Asst. in Chem.*
Sophie Hargis, B. S., *Asst. in Chem.*
Royal E. Jeffs, M. S. A., *Asst. in Bot.*
Carolyn Grimsby, B. S., *Reference Libr.*
Robina Rae, *Agr. Libr.*
Vera Dixon, B. S., *Asst. Libr.*
D. W. Sylvester, *Asst. in Agr. Engin.*
C. C. Fowler, B. S., *Asst. in Chem.*
Nellie Naylor, B. A., *Asst. in Chem.*
Charles Murray, B. Ped., *Asst. in Bact.*
H. E. Ewing, M. A., *Asst. in Zool.*
J. R. Campbell, B. S. A., *Asst. in Bot.*
Henry Ness, B. S. A., M. S., *Asst. in Zool.*
John P. Watson, *Phys. Dir.*
Margaret Forgeus, A. B., *Libr. Cataloguer.*
Mellie M. Smith, *Asst. Libr. Cataloguer.*
George Judisch, *Lect. in Pharm.*
John Reardon, *Gard.*

Agricultural Extension.

Perry G. Holden, M. S., B. Pd., *Supt.*
Ashley Van Storm, Ph. B., *in charge of Secondary Schools.*
A. H. Snyder, B. S. A., *Soils.*
Ralph K. Bliss, B. S. A., *Animal Husb.*
L. E. Troeger, B. S. A., *Asst. Animal Husb.*

Edith G. Charlton, *Dom. Sci.*
Neale S. Knowles, *Asst. in Dom. Sci.*
G. R. Bliss, B. S. A., *Hort.*
H. F. Lulck, B. S. A., *Dairying.*
C. R. Bush, B. S. A., *Dairying.*
J. W. Merrill, *Dairying (Marsh Test).*
E. B. Heaton, *Dairying (Marsh Test).*
William McArthur, *in charge Junior Corn Show Work.*

Iowa Agricultural Experiment Station, *Ames.*

Department of Iowa State College of Agriculture and Mechanic Arts, under the control of the Board of Trustees.

STATION STAFF.

C. F. Curtiss, M. S. A., D. S., *Dir.*
W. J. Kennedy, B. S. A., *V. Dir.; Animal Husb.*
S. A. Beach, B. S. A., M. S., *Hort.*
L. H. Pammel, M. S., Ph. D., *Bot.*
H. E. Summers, B. S., *Ent.*
C. H. Stange, D. V. M., *Vet.*
W. H. Stevenson, A. B., B. S. A., *Soils.*
I. G. McBeth, M. S. A., *Expt. in Soil Bact.*
S. L. Jodidi, Ph. D., *Expt. in Soils.*
J. B. Davidson, B. S. in M. E., *Agr. Engin.*
C. A. Scott, B. S. A., *For.*
Martin Mortensen, B. S. A., *Dairying.*
R. E. Buchanan, Ph. D., *Bact.*
J. H. Gordon, *Asst. Dairy Bact.*
E. E. Little, M. S. A., *Asst. Hort.*
Laurenz Greene, M. S. A., *Asst. Hort.*
L. C. Burnett,[a] M. S. A., *Asst. in Farm Crops; in charge of Plant Breeding.*
M. L. King, B. M. E., *Expt. in Agr. Engin.*
A. Leitch, B. S. A., *Asst. Animal Husb.*
E. N. Wentworth, M. S. A., *Asst. Animal Husb.*
H. H. Kildee, B. S. A., *Asst. Animal Husb.*
A. A. Wells, B. S., *Asst. Expt. in Soils.*
Harriette Kellogg, A. M., *Asst. Bot.*
Charlotte M. King, *Asst. Bot.*
R. L. Webster, A. B., *Asst. Ent.*
Stella A. Hartzell, A. M., *Asst. Chem.*
B. A. Madson, B. S. A., *Asst. Chem.*
T. J. Maney, *Asst. Chem.*
J. H. Allison, jr., *Asst. in Plant Introduction.*
C. V. Gregory, *Bulletin Editor.*
F. E. Colburn, *Photog.*

KANSAS.

Kansas State Agricultural College, *Manhattan.*

GOVERNING BOARD.

Board of Regents: W. E. Blackburn (*Pres.*), *Anthony;* J. O. Tulloss (*V. Pres.*), *Sedan;* Edwin Taylor, *Edwardsville;* Arthur Capper, *Topeka;* W. A. Harris, *Lawrence;* A. L. Sponsler, *Hutchinson;* H. J. Waters (*Sec. ex officio*), *Manhattan.*

COURSES OF STUDY.

There are thirteen four-year courses of study, viz: Agronomy, animal husbandry, dairy husbandry, poultry husbandry, horticulture and forestry, mechanical engineering, electrical engineering, civil engineering, architecture, printing, domestic science and art, general science (B. S.), and veterinary science (D. V. M.); postgraduate courses; five short courses—domestic science, requiring two terms of twelve weeks; farmers' courses, requiring two winter terms of ten weeks each; summer domestic science course for teachers; six weeks' summer school in agriculture for teachers; a dairy course, two terms of ten weeks each; a one-year preparatory course, and a farmers' week.

BOARD OF INSTRUCTION.

Henry J. Waters, B. S. A., *President.*

John D. Walters, D. A., *Archt. and Draw.*
Julius T. Willard, D. Sc., *Chem.*
Edw. H. Webster, B. Agr., M. S., *Dean Agr.*
Benj. L. Remick, Ph. M., *Math.*
Benj. F. Eyer, B. S., *Elect. Engin.*
Herbert F. Roberts, A. B., M. S., *Bot.*
Wm. A. McKeever, A. M., Ph. M., *Philos.*
Edmund B. McCormick, S. B. in M. E., *Dean Mech. Arts; Mech. Engin.; Supt. of Shops.*
Albert Dickens, M. S., *Hort.; Supt of Grounds; State Forester.*
Clark M. Brink, A. M., Ph. D., *Dean Sci.; Engl.*

[a] In cooperation with the U. S. Department of Agriculture.

Albert M. Ten Eyck, B. Agr., M. S., *Agron.; Farm Supt.*
Ralph R. Price, A. M., *Hist., Civics.*
Julius E. Kammeyer, A. M., *Econ.*
John V. Cortelyou, A. M., Ph. D., *German.*
Olof Valley, B. M., *Music.*
L. E. Conrad, M. S., *Civil Engin.*
Francis S. Schoenleber, M. S. A., D. V. S., M. D., *Vet. Sci.*
Roland J. Kinzer, B. S. A., *Animal Husb.*
Walter E. King, M. A., *Bact.*
T. J. Headlee, Ph. D., *Ent.*
Joshua D. Rickman, *Supt. of Print.*
Charles H. Boice, Lieut., U. S. A., *Mil. Sci.*
John C. Kendall, B. S., *Dairy Husb.*
John O. Hamilton, B. S., *Phys.*
Mrs. Mary P. Van Zile, *Dean of Women.*
Marguerite E. Barbour, *Dir. Phys. Training.*
Antonetta Becker, *Supt. Dom. Art.*
Robt. J. Barnett, B. S., *(Asst.) Math.*
Jacob Lund, M. S., *Supt. Heat and Power Dept.*
Margaret Butterfield, *Sec.*
Andrey A. Potter, B. S., *(Asst.) Mech. Engin.*
R. H. Brown, B. M., B. S., *(Asst.) Music.*
Estella Boot, *(Asst.) Engl.*
George A. Dean, M. S., *(Asst.) Ent.*
Wm. H. Andrews, A. B., *(Asst.) Math.*
Robert E. Eastman, M. S. A., *(Asst.) For.*
Leland E. Call, B. S. A., *(Asst.) Soils.*
Frank G. King, B. S., *(Asst.) Animal Husb.*
Wilmer E. Davis, B. S., *(Asst.) Bot.*
Ada Rice, B. S., *Instr. Engl.*
Ella Weeks, A. B., *Instr. Draw.*
Daisy Zeininger, B. A., *Instr. Math.*
Leonard W. Goss, D. V. M., *Instr. Vet. Sci.*
Ula M. Dow, B. S., *Instr. Dom. Sci.*
Theo. H. Scheffer, M. A., *Instr. Zool.*
Herbert H. King, M. A., *Instr. Chem.*
John B. Whelan, M. A., *Instr. Chem.*
Gertrude Barnes, *Libr.*
Kate Tinkey, *Asst. Libr.*
Florence Warner, A. B., *Ast. Libr.*
Jessie Gulick, *Asst. Libr.*
Mary Mudge, B. S., *Asst. Libr.*
Wm. L. House, *Foreman Carpenter Shop.*
Louis Wabnitz, *Foreman Mach. Shop.*
Ambrose E. Ridenour, B. S., *Foreman Foundry.*
Earle B. Milliard, *Foreman Blacksm.*
Ina E. Holroyd, B. S., *Asst. in Math. Dept.*
L. E. Chase, *Asst. in Hist. Dept.*
Ina F. Cowles, B. S., *Asst. in Dom. Art.*
Earl N. Rodell, B. S., *Asst. in Print.*
Roy A. Seaton, B. S., *Asst. in Mech. Engin.*
M. Francis Ahearn, M. S., *Asst. in Flor.*
J. C. Cunningham, B. S., *Asst. in Hort.*
Gertrude Stump, B. S., *Asst. in Dom. Art.*
Ethel Bierly, *Asst. in Dom. Art.*
J. T. Parker, *Asst. in Woodwork.*
A. E. White, M. S., *Asst. in Math.*
E. G. Meinzer, M. A., *Asst. in German.*
Burton Rogers, D. V. M., *Asst. in Vet. Sci.*
Clara Willis, *Asst. in Dom. Sci.*
Hugh Oliver, *Asst. in Heat and Power Dept.*
Charlaine Furley, B. A., *Asst. in Engl.*
Jessie Reynolds, A. B., *Asst. in Hist.*
S. W. McGarrah, A. M., *Asst. in Math.*
Madge Kay, S. B., *Asst. in Math.*
C. A. Jackson, B. S., *Asst. in Math.*
Annette Leonard, A. B., *Asst. in Engl.*
Wm. C. Lane, B. S., *Asst. in Elect. Engin.*
Louis H. Beall, A. B., *Asst. in Engl.*
Flora C. Knight, A. B., *Asst. in Engl.*
Grace H. Woodward, *Asst. in Dom. Sci.*
Margaret Mack, *Asst. in Hist. Dept.*
D. O. Stone, B. S., C. E., *Asst. in Civil Engin.*
E. P. Johnston, A. B., *Asst. in Public Speaking.*
Anna Monroe, B. S., *Asst. in Bot.*
Dean H. Rose, A. M., *Asst. in Bot.*
Paul W. Graff, B. S., *Asst. in Bot.*
Kirk H. Logan, B. S., *Asst. in Phys.*
C. A. A. Utt, B. S., *Asst. in Chem.*
Allen G. Phillips, B. S., *Asst. in Poultry Husb.*
A. B. Nystrom, B. S., *Asst. in Dairy Husb.*
A. Miyawaki, M. S., *Asst. in Expt. Dairying.*
J. B. Parker, M. A., *Asst. in Ent.*
Anna Gordon, A. B., *Asst. in Hist.*
Elizabeth Putnam, *Asst. in Draw.*
J. R. Jeness, B. S., *Asst. in Phys.*
Bertha M. Johnston, *Asst. in Dom. Sci.*
Harrison E. Porter, B. S., *Asst. in Math.*
Alexander Edgar, *Herdsman.*
L. D. Bushnell, B. S., *Asst. in Bact.*
R. C. Wiley, B. S., *Asst. in Chem.*
John E. Smith, B. S., *Asst. in Bot.*
K. W. Stouder, D. V. M., *Asst. Vet.*
R. C. Thompson, B. S., *Asst. in Chem.*
Porter J. Newman, B. S., *Asst. in Chem.*
Thomas G. Paterson, B. S. in Agr., *Asst. in Animal Husb.*
R. H. Wilson, D. V. M., *Asst. in Bact.*
Charles Doryland, B. S., *Asst. in Soils.*
Helen Huse, B. S., *Asst. in Dom. Sci.*
E. F. Kubin, D. V. M., *Surgeon, Vet. Dept.*
Turner R. H. Wright, B. S. in Agr., *Asst. in Animal Nutrition.*
Annie E. Lindsey, *Asst. in Dom. Sci.*
Bertha Donaldson, *Asst. in Dom. Art.*
L. E. Petty, *Asst. in Math.*
Bertha Bisby, *Asst. in Math. Dept.*
Floyd Howard, *Farm Foreman.*

Farmers' Institutes and Agricultural Extension.

John H. Miller, A. M., *Supt.*
George C. Wheeler, B. S., *Farm Management.*
P. E. Crabtree, *Farm Management.*
C. V. Holsinger, B. S., *Hort.*
C. H. Hinman, B. S., *Dairying.*
W. S. Gearhart, B. S. in C. E., *Highway Engin.*
Frances Brown, B. S., *Dom. Sci.*
J. E. Brock, B. S., *Sec.*

Kansas Agricultural Experiment Station, *Manhattan*.

Department of Kansas State Agricultural College, under the control of the Board of Regents.

STATION STAFF.

E. H. Webster, B. Agr., M. S., *Dir.*
J. T. Willard, D. Sc., *V. Dir.; Chem.*
H. F. Roberts, A. B., M. S., *Bot.*
Albert Dickens, M. S., *Hort.*
A. M. Ten Eyck, B. Agr., M. S., *Agron.*
F. S. Schoenleber, M. S. A., D. V. S., M. D., *Vet.*
R. J. Kinzer, B. S. A., *Animal Husb.*
T. J. Headlee, Ph. D., *Ent.*
W. E. King, M. A., *Bact.*
J. C. Kendall, B. S., *Dairy Husb.*
L. E. Call, B. S. A., *Asst. Agron.*
Chas. Doryland, B. S., *Asst. in Soils.*
C. W. Nash, B. S., *Asst. in Crops.*
F. G. King, B. S. in Agr., *Asst. Animal Husb.*
T. G. Paterson, B. S. in Agr., *Asst. Animal Husb.*
T. R. H. Wright, B. S. in Agr., *Asst. Animal Nutrition.*
Alex. Edgar, *Herdsman.*
L. D. Bushnell, B. S., *Asst. Bact.*
R. H. Wilson, D. V. M., *Asst. Bact.*
W. E. Davis, B. S., *Asst. Bot.*
Anna Monroe, B. S., *Asst. Bot.*
D. H. Rose, A. M., *Asst. Bot.*
C. O. Swanson, M. Agr., *Asst. Chem.*
R. C. Thompson, B. S., *Asst. Chem.*
R. C. Wiley, B. S., *Asst. Chem.*
A. Miyawaki, M. S., *Asst. Dairyman.*
A. G. Phillips, B. S. A., *Poultryman.*
W. A. Lamb, *Asst. Poultryman.*
G. A. Dean, M. S., *Asst. Ent.*
T. H. Scheffer, A. M., *Asst. Ent.*
J. B. Parker, M. A., *Asst. Ent.*
Harry P. Evans, B. S. A., *Asst. Ent.*
R. E. Eastman, M. S. A., *Asst. Hort.*
J. C. Cunningham, B. S., *Asst. Hort.*
E. F. Kubin, D. V. M., *Asst. Vet.*
F. M. Hayes, D. V. M., *Asst. Vet.*
Geo. K. Helder, *Asst. Supt. Fort Hays Branch Expt. Sta., Hays.*
J. A. Milham, B. S., *Asst. Animal Husb., Fort Hays Branch Expt. Sta., Hays.*
C. C. Cunningham, B. S., *Asst. Agron., Fort Hays Branch Expt. Sta., Hays.*
A. L. Hallsted,[a] B. S., *Asst. in Dry Farming, Fort Hays Branch Expt. Sta., Hays.*
Hiram R. Reed,[a] B. S., *Supt. Garden City Branch Expt. Sta., Garden City.*

KENTUCKY.

The State University, *Lexington*.

GOVERNING BOARD.

COURSES OF STUDY.

The following four-year courses of study are offered: Agriculture (B. S. Agr.); scientific, industrial chemistry, and domestic science (B. S.); two classical courses (A. B.); mechanical engineering (B. M. E.); civil engineering (B. C. E.); mining engineering (B. E. M.); two courses in education (B. S. Ed. and B. A. Ed., respectively); three-year preparatory course; two-year course and short winter course in agriculture; three-year courses in law, two-year courses in rural and highway engineering, and mining engineering, and a short course for miners.

BOARD OF INSTRUCTION.

James K. Patterson, Ph. D., LL. D., *President; Metaphysics, History, and Political Economy.*

James G. White, A. M., *V. Pres.; Math., Astron.*
Clarence W. Matthews, B. S., *Dean of Agr. College; Agr., Hort., Bot.; Sec.*
J. J. Hooper, M. S. A., *Animal Husb.*
Franklin E. Tuttle, Ph. D., *Chem.*
Ralph N. Maxson, Ph. D., *Chem.*
George Roberts, M. S., *Agron.*
Arthur M. Miller, A. M., *Dean of College of Arts and Sci.; Zool., Ent., Geol.*
Alexander St. Clair MacKenzie, A. M., *Engl., Logic.*

[a] In cooperation with the U. S. Department of Agriculture.

Merry L. Pence, M. S., *Phys.*
Joseph W. Pryor, M. D., *Anat. and Physiol.; Surgeon.*
Alfred C. Zembrod, A. M., *French, German.*
Walter E. Rowe, M. S., M. C. E., *Civil Engin.*
Louis F. Snow, Ph. D., *Dean College of Ed.*
J. T. C. Noe, A. M., (*Assoc.*) *Ed.*
Philip W. Corbusier, M. C. E., Lieut., U. S. A., *Mil. Sci.; Comdt.*
Mrs. Florence O. Stout, *Phys. Dir. and Dean of Women.*
W. Walter H. Mustaine, B. S., *Phys. Dir. for Men.*
W. K. Patterson, A. M., *Prin. of Academy.*
C. R. Melcher, A. M., LL. B., (*Assoc.*) *French, German.*
J. M. Davis, B. S., A. M., (*Assoc*) *Math.*
Wm. S. Webb, M. S. (*Asst.*) *Phys.*
Jas. E. Tuthill, Ph. D., (*Asst.*) *Hist.; Econ.*
W. J. Carrel, B. S., C. E., (*Asst.*) *Civil Engin.*
Isabella W. Marshall, A. B., *Instr. Dom. Sci.*
Sue D. McCann, M. S., *Instr. Zool., Ent.*
Lloyd C. Daniels, Ph. D., *Instr. Chem.*
Elizabeth S. Kinkead, *Lect. on Engl. Lit.*
Alfred H. Gilbert, B. S., *Asst. in Bot. Hort.*
Harry Essex, A. B., *Asst. in Chem.*
Robert C. Terrell, B. C. E., *Asst. in Rural and Highway Engin.*
E. L. Rees, C. E., *Asst. in Math.*
H. H. Downing, B. C. E., *Asst. in Math.*
E. F. Farquhar, A. M., *Asst. in Engl.*
C. R. Egelhoff, A. B., *Asst. in Hist.*
A. G. McGregor, *Asst. in Academy.*
Knox Jamison, B. S., *Asst. in Academy.*
W. S. Hamilton, A. B., *Asst. in Academy.*
E. L. Harrison, A. B., *Asst. in Academy.*
M. R. Schnaitter, B. S., *Asst. in Academy.*
Margaret I. King, A. B., *Registrar.*

Kentucky Agricultural Experiment Station, *Lexington.*

Department of the State University, under the control of the Board of Trustees.

STATION STAFF.

M. A. Scovell,[a] M. S., Ph. D., *Dir.; Chem.*
A. M. Peter, M. S., *Chief Chem.; Head of Chem. Div.*
H. E. Curtis, M. S., *Chief Chem.; Head of Fert. Div.*
Harrison Garman, *Ent., Bot.; Head of Ent. and Bot. Div.*
W. H. Scherffius,[a] M. S., *Agron.; Head of Agr. Div.*
R. M. Allen, A. B., *Head of Food Div.*
J. D. Turner, B. Ped., *Head of Feed Div.*
J. O. LaBach, M. S., *Chief Chem.* (*Food Div.*).
Mary L. Didlake, M. S., *Asst. Ent., Bot.*
S. D. Averitt, M. S., *Chem* (*Chem. Div.*).
O. M. Shedd, M. S., *Chem.* (*Chem. Div.*).
George Roberts, B. Ped., M. S., *Chem.* (*Fert. Div.*); *Actg. Agron.*
E. C. Vaughn, A. B., *Asst. Ent., Bot.*
E. S. Good, M. S., *Head of Animal Husb. Div.*
J. W. Nutter, *Asst. in Dairying* (*Animal Husb. Div.*).
H. D. Spears, M. S., *Chem.* (*Feed Div.*).
E. F. Worthington, *Farm Supt.*
J. W. McFarlin, B. S., *Insp.*
B. F. Scherffius, B. Agr., *Insp.*
E. J. Kinney, B. S. Agr., *Asst. Ent., Bot.*
T. R. Bryant, B. S. Agr., *Asst. Animal Husb.*
H. C. Woosley,[b] B. Agr., *Special Agt.*
Wm. Rodes, B. S., *Asst. Chem.* (*Fert. Div.*)
W. C. Matthews, A. B., *Artist.*
L. A. Brown, Ph. C., Phar. D., *Chem.* (*Drug Div.*).
John I. Claybrook, *Insp.*

The Kentucky Normal and Industrial Institute for Colored Persons, *Frankfort.*

GOVERNING BOARD.

Board of Trustees: J. G. Crabbe (*Chair.*), *Frankfort;* E. E. Hume, *Frankfort;* J. C. Mastin, *Frankfort;* E. E. Underwood, *Frankfort;* John H. Jackson (*ex officio*), *Frankfort;* M. A. Cassidy, *Lexington.*

COURSES OF STUDY.

The courses of study are ten: Normal, carpentry, agricultural, business, cooking, music, dressmaking, blacksmithing, wheelwrighting, and printing. The school grants State diplomas to normal graduates.

BOARD OF INSTRUCTION.

John H. Jackson, A. M., *President; Pedagogy, Ethics, and History of Education.*

W. H. Clarke, A. M., *Dean and Dir. Dept. Nat. Sci.*
Will M. Jackson, *Steward; Instr. Normal Dept.*
James L. Lawson, *Supt. of Indus.; Dir. of Mech. and Manual Training.*
P. W. L. Jones, A. M., *Prin. of Prep. Dept.*
Lulu L. Coleman, *Libr.; Instr. Normal Dept.*

[a] On leave. [b] Assigned by the U. S. Department of Agriculture.

Ernest E. Reed, *Instr. Prep. and Normal Depts.*
Frankie B. Watkins, *Instr. Prep. Dept.*
A. L. Mebane, *Instr. Sci. Agr.*
Mrs. Addie G. Smith, *Matron; Instr. Cooking.*
John H. Rives, *Instr. Print.*
Lydia M. Miller, *Instr. Sew. and in Prep. Dept.*
Sylvester F. Collins, *Sec. to Pres.; Dir. Business Course.*
Laura Smith, *Dir. Dept. of Music.*

LOUISIANA.

Louisiana State University and Agricultural and Mechanical College, *Baton Rouge.*

GOVERNING BOARD.

Board of Supervisors: Gov. J. Y. Sanders (*ex officio Pres.*), *Baton Rouge;* Henry L. Fuqua* (*V. Pres.*), *Baton Rouge;* S. McC. Lawrason, *St. Francisville;* Hon. T. H. Harris (*ex officio Supt. Public Education*), *Baton Rouge;* Thos. D. Boyd* (*ex officio Pres State University*), *Baton Rouge;* A. T. Prescott (*Sec.*), *Baton Rouge;* Roger P. Swire (*Treas.*), *Baton Rouge;* H. S. Chenet, *New Orleans;* C. J. Ducote, *Cottonport;* C. C. Davenport, *Merrouge;* George K. Pratt, *New Orleans;* George Hill, *Port Allen;* J. R. Thornton, *Alexandria;* G. H. Clinton, *St. Joseph;* J. W. Sanders, *New Iberia;* Jos. H. Spearing, *Shreveport;* W. M. Lyles, *Leesville.*

COURSES OF STUDY.

In addition to the courses of study in the college of arts and sciences and the teachers' college, there are the three-year course of the school of agriculture, and the four-year course of the college of agriculture; four-year courses in civil engineering, electrical engineering, mechanical engineering, and commerce; and five-year sugar engineering and chemical engineering courses.

BOARD OF INSTRUCTION.

Thomas D. Boyd, A. M., LL. D., *President.*

James W. Nicholson, A. M., LL. D., *Math.*
W. R. Dodson, A. B., B. S., *Agr.*
Edward L. Scott, M. A., *Ancient Lang.; Sec.*
Boykin W. Pegues, B. S., *Civil Engin.*
Wm. A. Read, Ph. D., *Engl.*
Charles E. Coates, Ph. D., *Chem.*
Ernst A. Bessey, Ph. D., *Bot., Bact.*
Thomas W. Atkinson, B. S., C. E., *Phys., Elect. Engin.*
Albert M. Herget, *Mech. Arts, Draw.*
Arthur T. Prescott, M. A., *Polit. Sci.*
Charles H. Stumberg, M. A., *Mod. Lang.*
William H. Dalrymple, M. R. C. V. S., *Vet. Sci.*
L. S. Sorley, Capt., U. S. A., *Mil. Sci. and Tactics; Comdt. of Cadets.*
E. C. McKeag, Ph. D., *Civil Law.*
George Tiebout, B. S., *Hort.*
Robt. L. Hines, *Commerce.*
E. W. Kerr, M. E., *Mech. Engin.*
W. B. Clark, *Dir. Music.*
R L. Henry, J. D., *Common Law.*
R. L. Tullis, LL. B., *Louisiana Jurisprudence.*
Alex. B. Coffey, A. M., *Pedag.*
D T. Powers, A. M., (*Assoc.*) *Ed.*
Walter L. Fleming, Ph. D., *Hist.*
A. G. Reed, Ph. D., *Engl. Lit.*
S. T. Sanders, B. A., (*Asst.*) *Math.*
E. L. Jordan, B. S., (*Asst.*) *Animal Husb.*
W. H. Gates, B. A., (*Actg.*) *Zool., Ent.*
V. L. Roy, B. A., *Agr. Ed.*
Charles McVea, M. D., *Surgeon.*
James F. Broussard, A. M., (*Asst.*) *Mod. Lang.*
Hugh M. Blain, Ph. D., (*Assoc.*) *Engl.*
A. F. Kidder, B. S., (*Asst.*) *Agron.; Prin. School of Agr.*
J. G. Prichard, *Dir. of Athletics.*
Raoul L. Menville, B. S., *Instr. Chem.*
Linton L. Cooper, B. S., *Instr. Mech. Arts, Draw.*
Max Bernheim, B. S., *Instr. Mech. Engin.*
Wm. O. Scroggs, A. M., *Asst. in Hist. and Econ.*
Mercedes Garig, *Asst. in Engl.*
D. W. Thomas, A. B., *Asst. in Lat.*
B. J. Sandoz, B. S., *Asst. in Sugar Chem.*
D. D. Cline, A. M., *Asst. in Math.*
N. F. Petersen, B. A., *Asst. in Bot.*
A R. Guell, *Asst. in Spanish.*
S. W. Plauche, B. S., *Asst. in Phys.*
M. G. Osborne, A. B., *Sec.*
Inez Mortland, *Asst. Libr.*

No. 1. Sugar Experiment Station, *Audubon Park, New Orleans.*
No. 2. State Experiment Station, *Baton Rouge.*
No. 3. North Louisiana Experiment Station, *Calhoun.*
No. 4. Rice Experiment Station, *Crowley.*

Department of Louisiana State University and Agricultural and Mechanical College.

GOVERNING BOARD.

State Board of Agriculture and Immigration: Gov. J. Y. Sanders (*Pres. ex officio*), *Baton Rouge;* Henry L. Fuqua (*V. Pres. ex officio*), *Baton Rouge;* Chas. Schuler (*Comr.*

ex officio), *Baton Rouge;* Thos. D. Boyd (*Pres. State Univ. ex officio*), *Baton Rouge;* W. R. Dodson (*Dir. Expt. Stas.*), *Baton Rouge;* J. J. Henderson, *Lagan;* Henry Gerac, *Lafayette;* J. T. Cole, *Monroe;* R. E. Thompson, *Wilson;* J. D. Marks, *Crowley.*

STATION STAFF.

Sugar Experiment Station, *Audubon Park, New Orleans.*

W. R. Dodson, A. B., B. S. (*Baton Rouge*), *Dir.*
H. P. Agee, B. S., *Asst. Dir.; Chem.*
P. A. Yoder, Ph. D., *Chem.*
Wm. L. Owen, B. S. A., *Bact.*
W. G. Taggart, B. S., *Asst. Chem.*
R. E. Graham, B. S., *Asst. Chem.*

State Experiment Station, *Baton Rouge.*

W. R. Dodson, A. B., B. S., *Dir.*
S. E. McClendon, B. S., *Asst. Dir.*
W. H. Dalrymple, M. R. C. V. S., *Vet.*
George Tiebout, *Hort.*
Claude W. Edgerton, Ph. D., *Plant Path.*
Jas. E. Halligan, B. S., *Chem.*
H. L. Green, B. S., *Asst. Chem.*
A. P. Kerr, B. S., *Asst. Chem.*
Rene Baus, B. S., *Asst. Chem.*
R. G. Fuller, B. S., *Asst. Chem.*
Robt. G. Tillery, B. S., *Asst. Chem.*
G. D. Harris, M. S., M. A., *Geol.*
R. P. Swire, *Treas.*
J. T. Tanner, A. B., *Sec.*
Thos. C. Paulsen, B. S., M. D. C., *Animal Path.*
E. W. Kerr, M. E., *Mech. Engin.*
Victor L. Roy, B. S., *Agr. Ext. Work.*

North Louisiana Experiment Station, *Calhoun.*

W. R. Dodson, A. B., B. S. (*Baton Rouge*), *Dir.*
J. B. Garrett, B. S., *Asst. Dir.*
E. J. Watson, *Hort.*
Ivy Watson, *Farm Mgr.*

Rice Experiment Station, *Crowley.*

W. R. Dodson, A. B., B. S. (*Baton Rouge*), *Dir.*
F. C. Quereau, B. S., *Asst. Dir.*

Southern University and Agricultural and Mechanical College, *New Orleans.*

GOVERNING BOARD.

Board of Trustees: E. A. Carrere (*Pres.*), *806 Perdido st., New Orleans;* C. R. Panter (*Sec. and Treas.*), *2320 Calhoun st., New Orleans;* W. L. Richeson, *4936 Camp st., New Orleans;* Wm. G. Napp, *5000 Prytania st., New Orleans;* L. Robert Rivarde, *Hennen Building, New Orleans;* F. L. Armstrong, *1636 Arabella st., New Orleans;* U. Marinoni, *730 Common st., New Orleans;* A. H. Hanemann, *2816 Grand Route St. John, New Orleans;* Ernest Ducongé *5116 Magazine st., New Orleans;* H. H. Freeman, *5222 Chestnut st., New Orleans;* J. W. Cooke, *Lake Providence;* E. W. Sorrell, *Plaquemine.*

COURSES OF STUDY.

The university is divided into the following departments: College, normal school, high school (college preparatory), grammar school, department of music, and industrial department. In the industrial department there is an agricultural school, a mechanical school, girls' industrial school, school of printing, and a dairy school, the first two having two and four year courses and the last a two-year course.

BOARD OF INSTRUCTION.

H. A. Hill, *President; Mental and Moral Philosophy.*

F. L. St. Martin, *Supt. Agr. Dept.*
E. P. Barrell, *Chem., Phys.*
Wm. F. Winslow, *Engl., Ancient Lang.*
W. J. Nickerson, *Prin. Music Dept.*
Mrs. E. P. Barrell, *Prin. Girls' Indus. Section.*
Mrs. L. M. Martinet, *Math.*
Ernestine M. Theophile, *Asst. in Math.*
Miss A. F. Lewis, *Engl.; Teacher in High School.*
Lillie S. Larkins, *Phys., Geog.*
Miss M. C. Caufield, *El. Sci.*
Mrs. A. T. Getz, *Physiol.*
W. B. Smith, *Hist.*
S. J. Green, *Asst. in Math.*
A. J. Bell, *Asst. in Engl.*

MAINE.

College of Agriculture of the University of Maine, *Orono.*

GOVERNING BOARD.

COURSES OF STUDY.

There are four-year elective courses in classics (B. A.) and general science (B. S.); four-year technical courses in chemistry, veterinary science and bacteriology, pharmacy, agronomy, animal husbandry, poultry husbandry, horticulture, forestry, domestic science, and civil, mechanical, electrical, and chemical engineering (B. S.); a four-year course for teachers in elementary agriculture (B. S.); a three-year course in School of Laws (LL. B.); a two-year course in pharmacy (Ph. C.); two-year school course in agriculture; winter courses in agriculture and dairying of four weeks, followed by a three weeks' course in domestic science and poultry management; correspondence courses in agriculture, and a farmers' week.

BOARD OF INSTRUCTION.

George Emory Fellows, Ph. D., L. H. D., LL. D., *President of the University; History.*

Melvin E. Sherwin, M. S., (*Asst.*) *Agron.*
George E. Simmons, M. S., *Agr. Ext. Work.*
Percy A. Campbell, M. S. A., *Animal Indus.*
James R. Dice, B. S., *Instr. Animal Indus.*
Gilman A. Drew, Ph. D., *Biol.*
Fremont L. Russell, B. S., V. S., *Bact., Vet. Sci.*
Alice M. Boring, Ph. D., *Instr. Biol.*
Mintin A. Chrysler, Ph. D., (*Assoc.*) *Bot.*
Harry N. Conser, M. A., M. S., *Instr. Bot.*
Lucius H. Merrill, Sc. D., *Biol. and Agr. Chem.*
Ralph H. McKee, Ph. D., *Chem.*
Charles W. Easley, Ph. D., (*Assoc.*) *Chem.*
Willis F. Washburn, B. S., *Instr. Chem.*
Benjamin E. Kraybill, M. S., *Instr. Chem.*
Robert J. Sprague, Ph. D., *Econ., Sociol.*
Roland P. Gray, B. A., *Engl.*
Laura Comstock, (*Asst.*) *Dom. Sci., Home Econ.*
W. A. Brown, B. S. A., (*Asst.*) *Poultry Husb.*
Guy A. Thompson, M. A., (*Asst.*) *Engl.*
Walter E. Prince, M. A., *Instr. Engl.*
George E. Pearson, M. A., *Instr. Engl.*
W. P. Daggett, Ph. B., *Public Speaking.*
Gordon E. Tower, B. S., M. F., *For.*
Garrett W. Thompson, Ph. D., *German.*
Robert R. Drummond, B. S., *Instr. German.*
Carolyn Colvin, Ph. D., *Hist.*
V. R. Gardner, M. S. A., (*Asst.*) *Hort.*
Wintha R. Palmer, B. S., *Instr. Hort.*
James N. Hart, Sc. D., C. E., *Math., Astron.*
Trueman L. Hamlin, M. A., (*Asst.*) *Math.*
Sherman D. Chambers, B. S., *Instr. Math.*
Walter E. Wilbur, B. S., *Instr. Math.*
Lowell J. Reed, B. S., *Instr. Math.*
Charles P. Weston, C. E., M. A., *Mech. Draw.*
Archer L. Grover, B. S., *Asst. in Draw.*
Charles A. Varnum, Lieut. Col., U. S. A. (Retired), *Mil. Sci. and Tactics.*
Wallace Craig, Ph. D., *Philos.*
James S. Stevens, LL.D., *Phys.*
Leon E. Woodman, M. A., (*Asst.*) *Phys.*
George A. Scott, B. S. in E. E., *Instr. Phys.*
Ernest C. Drew, B. S., *Instr. Phys.*
Jacob B. Segall, Ph. D., *Romance Lang.*
Andrew P. Raggio, Ph. D., (*Asst.*) *Romance Lang.*
Ralph K. Jones, B. S., *Libr.*

Maine Agricultural Experiment Station, *Orono.*

Department of the University of Maine, under the control of the Board of Trustees of the University.

STATION STAFF.

Chas. D. Woods, Sc. D., *Dir.*
Harry M. Woods, A. B., *Asst. to Dir.*
Ralph K. Jones, *Libr.*
Chas. J. Dunn, *Treas.*
Raymond Pearl, Ph. D., *Biol.*
Frank M. Surface, Ph. D., *Assoc. Biol.*
Maynie R. Curtis, A. M., *Asst. Biol.*
Walter Anderson, *Poultryman.*
James M. Bartlett, M. S., *Chem.*
Herman H. Hanson, M. S., *Assoc. Chem.*
Jos. F. Merrill, B. S., *Asst. Chem.*
Albert G. Durgin, M. S., *Asst. Chem.*
Edith M. Patch, B. S., *Ent.*
Oskar A. Johannsen, Ph. D., *Assoc. Ent.*

Alice W. Averill, *Lab. Asst. in Ent.*
Walter W. Bonns, B. S. A., *Assoc. Hort.*
Warner J. Morse, M. S., *Plant Path.*
Chas. E. Lewis, Ph. D., *Assoc. Plant Path.*
John Summers, *Lab. Asst. in Plant Path.*
Royden L. Hammond, *Seed Analyst, Photog.*
Henry A. Millett, *Met. Observer.*
Wellington Sinclair, (*Monmouth*), *Farm Supt.*

MARYLAND.

Maryland Agricultural College, *College Park.*

GOVERNING BOARD.

Board of Trustees: *Ex officio*—Gov. Austin L. Crothers (*Pres.*), *Annapolis*; J. W. Hering, *Westminster*; I. L. Straus, *Baltimore*; Murray Vandiver * (*State Treas.*), *Havre de Grace*; Joseph B. Seth, *Easton*; Hon. James Wilson, *Washington, D. C.*; J. Enos Ray, *Washington, D. C.* Richard S. Hill, *Upper Marlboro*; Chas. H. Stanley, *Laurel*; E. Gittings Merriman, *Cockeysville*; J. Harold Walsh, *Upper Falls*; F. Carroll Goldsborough,* *Easton*; David Seibert,* *Clear Spring*; Robert Crain,* *Baltimore*; Chas. A. Councilman,* *Glyndon*; J. M. Munroe, *Annapolis*; John Hubert, *Baltimore*; W. Lee Cary, *Berlin.*

COURSES OF STUDY.

There are eight four-year courses of study, viz: Agricultural, horticultural, general science, biological, and chemical (B. S.), mechanical engineering (B. S. M. E.), civil engineering (B. S. C. E.), and electrical engineering; two-year courses in agriculture and horticulture; one-year preparatory course, and a ten weeks' winter course in agriculture.

BOARD OF INSTRUCTION.

R. W. Silvester, M. S., LL. D., *President; Mathematics.*

Thomas H. Spence, A. M., *V. Pres.; Lang.*
H. B. McDonnell, B. S., M. D., *Dean of Chem.; State Chem.*
W. T. L. Taliaferro, A. B., *Dean of Agr.*
Henry T. Harrison, A. M., *Prin. of Prep. Dept.; (Asst.) Math.; Sec. of Faculty.*
James S. Robinson, *Hort. Emeritus.*
Samuel S. Buckley, M. S., D. V. S., *Vet. Sci.*
F. B. Bomberger, B. S., A. M., *Engl., Civics; Libr.*
Charles S. Richardson, A. M., *Oratory, (Asst.) Engl.; Dir. Phys. Culture.*
J. B. S. Norton, M. S., *Veg. Path., Bot.; State Path.*
T. B. Symons, M. S., *Ent., Zool.; State Ent.*
C. P. Close, M. S., *Hort.; State Hort.*
T. H. Taliaferro, C. E., Ph. D., *Civil Engin., Elect. Engin.; Phys.*
Edgar T. Conley, Capt., U. S. A., *Comdt. of Cadets; Mil Sci.*
Herman Beckenstrater, B. S., (*Assoc.*) *Hort.*
Harry Gwinner, M. E., *Mech. Engin.*
Myron Creese, B. S., E. E., (*Asst.*) *Phys., Elect. Engin.*
Granville Hibberd, B. S. A., (*Asst.*) *Animal Husb.*
H. L. Crisp, (*Asst.*) *Mech. Engin.*
Leonard M. Peairs, M. S., *Instr. Ent., Zool. (State Work).*
Alvah J. Norman, B. S. A., *Instr. Veg. Path., Bot. (State Work).*
Frederick F. Mason, B. S., M. E., *Instr. Mech. Engin.*
I. V. Stone, B. S., A. M., *Instr. Chem.*
Cornelius Beatty, A. B., *Asst. in Chem. (State Work).*
R. B. Deemer, B. S., *Asst. in Chem. (State Work).*
F. W. Besley, A. B., M. F., *Lect. on For.; State For.*
Harry Nalley, M. D., *Surgeon.*
Frank R. Kent, *Registrar, Treas.*

Maryland Agricultural Experiment Station, *College Park.*

Department of Maryland Agricultural College, under the control of the Board of Trustees.

STATION STAFF.

Harry J. Patterson, B. S., *Dir.; Chem.*
S. S. Buckley, M. S., D. V. S., *Vet.*
J. B. S. Norton, M. S., *Bot., Path.*
T. B. Symons, M. S., *Ent. (State Work).*
C. P. Close, M. S., *Hort.*
Nickolas Schmitz, B. S., *Agron.*
Geo. E. Gage, Ph. D., *Assoc. Biol. (Poultry Invest.).*
E. H. Brinkley, *Farm Supt.*
Thos. H. White, *Gard.*
A. B. Gahan, M. S., *Asst. Ent.*
W. R. Ballard, B. S., *Asst. Hort.*

C. L. Opperman, *Assoc. Poultryman.*
L. M. Peairs, M. S., *Asst. Ent. (State Work).*
A. J. Norman, B. S. A., *Asst. Bot. (State Work).*
A. L. Stabler, B. S., *Asst. Animal Husb.*
L. B. Broughton, B. S., *Asst. Chem.*
J. H. Pritts, *Clerk, Libr.*
F. R. Kent, *Treas.*

Princess Anne Academy for Colored Persons, *Princess Anne.*

GOVERNING BOARD.

COURSES OF STUDY.

A two-year grammar course, a four-year academic, a four-year normal, and industrial courses in domestic science, printing, agriculture, carpentry, joinery, blacksmithing, wheelwrighting, and painting are offered.

BOARD OF INSTRUCTION.

Frank Trigg, A. M., *Principal; English and Geography.*

Ellen P. Trigg, *Housekeeping, Laundering.*
Daniel J. Pinkett, *Math.*
Woodard W. Privott, *Blacksm., Wheeler.*
Hattie L. Lumpkins, *Dom. Sci. and Art.*
L. Angelia Turpeau, A. B., *Matron-Preceptress; Engl.*
Crafton C. Reed, *Print.*
George T. Cordery, *Carpentry, Joinery.*
John E. Smith, *Phys. Sci., Agr.*
John H. Jones, *Farm Foreman.*
Henry J. Hitch, *Market Gard.*
Samuel S. Taylor, *Lat., Ed.*
Mamie M. Turner, *Engl., Pract. Ed., Critic Teacher.*

MASSACHUSETTS.

Massachusetts Agricultural College, *Amherst.*

GOVERNING BOARD.

COURSES OF STUDY.

The collegiate course of study requires four years and leads to the degree of B. S. Graduate courses, short winter courses in dairying, agriculture, horticulture, and floriculture, and a summer school of agriculture are provided.

BOARD OF INSTRUCTION.

Kenyon L. Butterfield, A. M., *President; Rural Sociology.*

George F. Mills, M. A., *Dean; Head of Div. of Humanities; Lang., Lit.*
Charles H. Fernald, PH. D., *Dir., Graduate School; Zool.*
Wm. P. Brooks,* PH. D., *Lect. on Soil Fert.*
William D. Hurd, B. S., M. AGR., *Dir. of Short Courses.*
Frank A. Waugh, M. S., *Head of Div. of Hort.; Landscape Gard.*
James A. Foord, M. S., *Actg. Head of Div. of Agr.; Farm Administration.*

Charles A. Goessmann, Ph. D., LL. D., *Honorary Chem.*
Charles Wellington, Ph. D., *Gen. and Agr. Chem.*
James B. Paige, B. S., D. V. S., *Vet. Sci.*
George E. Stone, Ph. D., *Bot.*
John E. Ostrander, A. M., C. E., *Math., Civil Engin.*
Henry T. Fernald, Ph. D., *Ent.*
George C. Martin, C. E., Capt., U. S. A., *Mil. Sci. and Tactics.*
William R. Hart, A. M., *Agr. Ed.*
Edward A. White, B. S., *Flor.*
Fred C. Sears, M. S., *Pomol.*
Philip B. Hasbrouck, B. S. *(Assoc.), Math. (Adjunct) Physics; Registrar.*
Jos. S. Chamberlain, Ph. D., *(Assoc.) Chem.*
Fred C. Kenney, *Treas.*
Charles R. Green, B. Agr., *Libr.*
S. Francis Howard, M. S., *(Asst.) Chem.*
A. Vincent Osmun, M. S., *(Asst.) Bot.*
Clarence E. Gordon, B. S., A. M., *(Asst.) Zool.; Curator of Zool. Museum.*
Robert W. Neal, A. M., *(Asst.) Engl.*
Percy L. Reynolds, M. D., *(Asst.) Phys. Ed. and Hygiene.*
William P. B. Lockwood, B. S. Agr., *(Asst.) Dairying.*
E. K. Eyerly, Ph. D., *(Asst.) Polit. Sci., Lect. on Rural Sociol.*
Robert W. Lyman, B. S., LL. B., *Lect. on Farm Law.*
George N. Holcomb, A. B., S. T. B., *Lect. on Polit. Sci.*
Sidney B. Haskell, B. S., *Instr. Agron.*
Harold F. Tompson, B. S., *Instr. Market Gard.*
Ray L. Gribben, B. S. A., *Instr. Animal Husb.*
Floyd B. Jenks, B. S. A., *Instr. Agr. Ed.*
Edgar L. Ashley, A. M., *Instr. German.*
Anderson A. Mackimmie, A. B., *Instr. French, Spanish.*
C. Robert Duncan, B. S., *Instr. Math., Phys.*
Alex. E. Cance, Ph. D., *Instr. Agr. Econ.*
F. B. McKay, *Instr. Engl., Public Speaking.*
Harry M. Jennison, B. S., *Asst. in Bot.*
John Noyes, B. S., *Asst. in Landscape Gard.*
John N. Summers, B. S., *Asst. in Ent.*
Edwin H. Forristall, M. S., *Farm Supt.*
John R. Parker, B. S., *Asst. in Ent.*
Ralph J. Watts, B. S., *Sec. to President.*
Charles H. White, B. S., *Field Agt.*

Massachusetts Agricultural Experiment Station, *Amherst.*

Department of the Massachusetts Agricultural College, under the control of the Board of Trustees.

STATION STAFF.

Wm. P. Brooks,* Ph. D., *Dir.; Agr.*
Chas. A. Goessmann, Ph. D., LL. D., *Honorary Dir.; Expert Consulting Chem.*
Jos. B. Lindsey, Ph. D., *Chem.*
G. E. Stone, Ph. D., *Bot., Veg. Path.*
C. H. Fernald, Ph. D., *Ent.*
J. B. Paige, B. S., D. V. S., *Vet.*
F. A. Waugh, M. S., *Hort.*
J. E. Ostrander, A. M., C. E., *Met.*
H. T. Fernald, Ph. D., *Assoc. Ent.*
Edw. B. Holland, M. S., *Assoc. Chem. (Research Div.).*
Henri D. Haskins, B. S., *Chem. (Fert. Div.).*
Philip H. Smith, B. S., *Chem. (Feed and Dairy Div.).*
F. C. Sears, M. S., *Pomol.*
Henry J. Franklin, Ph. D., *Asst. Ent. in charge of Cranberry Substa.*
Erwin S. Fulton, B. S., *First Asst. Agr.*
E. F. Gaskill, B. S., *Second Asst. Agr.*
Lewell S. Walker, B. S., *First Asst. Chem.*
George H. Chapman, B. S., *Asst. Bot.*
J. K. Shaw, B. S. A., M. S., *Asst. Hort.*
J. N. Summers, B. S., *Asst. Ent.*
J. C. Reed, B. S., *Asst. Chem.*
Carl D. Kennedy, B. S., *Asst. Chem.*
F. C. Kenney, *Treas.*
C. R. Green, B. Agr., *Libr.*
James T. Howard, *Insp.*
Roy F. Gaskill, *Asst. in Animal Nutrition.*
Charles M. Damon, *Observer.*

MICHIGAN.

Michigan State Agricultural College, *East Lansing.*

GOVERNING BOARD.

State Board of Agriculture: R. D. Graham *(Pres.), Grand Rapids;* A. J. Doherty, *Clare;* I. R. Waterbury, *Highland;* W. H. Wallace, *Bay Port;* Jonathan L. Snyder *(Pres. College, ex officio), East Lansing;* A. P. Bliss, *Saginaw;* W. L. Carpenter, *Detroit;* Gov. Fred M. Warner *(ex officio), Lansing;* L. L. Wright *(Supt. of Public Instr. ex officio), Lansing;* William J. Oberdorffer, *Stephenson;* A. M. Brown *(Sec.), East Lansing;* B. F. Davis *(Treas.), Lansing.*

COURSES OF STUDY.

There are four four-year courses of study, viz: Agricultural, engineering, forestry, and home economics (B. S.); short courses in general agriculture, poultry culture, cheese making, dairy management, and horticulture; postgraduate and preparatory courses; a college extension reading course; summer courses in forestry, and a four weeks' summer school for teachers of agriculture and domestic science.

BOARD OF INSTRUCTION.

Jonathan L. Snyder, A. M., PH. D., LL. D., *President.*

William J. Beal, PH. D., D. Sc., *Bot.*
Herman K. Vedder, C. E., *Civil Engin.*
L. R. Taft, M. S., *Supt. of Farmers' Insts., State Insp. Orchards and Nurseries.*
Walter B. Barrows, B. S., *Zool., Geol., Physiol.; Curator Gen. Mus.*
Frank S. Kedzie, M. S., *Chem.*
Leslie M. Hurt, D. V. M., *Vet. Sci.*
Chas. E. Marshall, PH. D., *Bact., Hyg.*
Robert S. Shaw, B. S. A., *Dean Agr., Vet. Sci., Hort., For.*
G. M. Holley, Lieut., U. S. A., *Mil. Sci. and Tactics; Comdt. of Cadets.*
J. Fred. Baker, M. F., *For.*
Jos. A. Jeffery, B. S., *Soils, Soil Phys., Agron.*
H. J. Eustace, B. S., *Hort.*
Chase Newman, *(Asst.) Draw.*
Arthur R. Sawyer, A. B., E. E., *Phys., Elect. Engin.*
Thos. C. Blaisdell, PH. D., *Engl. Lit., Mod. Lang.*
Wilbur O. Hedrick, M. S., *Hist., Polit. Econ.*
Maude Gilchrist, A. M., *Dean of Women's Dept.*
Walter H. French, *Agr. Ed.*
Warren Babcock, B. S., *Math.; Sec. of Faculty.*
Rufus H. Pettit, B. S. AGR., *Ent.*
A. Crosby Anderson, B. S., *(Assoc.) Dairy Husb.*
E. Sylvester King, *(Asst.) Engl.*
Mrs. Linda E. Landon, *Libr.*
C. L. Brewer, B. S., *Dir. Phys. Culture.*
James B. Dandeno, PH. D., *(Asst.) Bot.*
H. S. Reed, B. S. AGR., *(Asst.) Chem.*
Jesse J. Myers, B. S., *(Asst.) Zool.*
E. H. Ryder, M. A., *(Asst.) Hist., Econ.*
Otto Rahn, PH. D., *(Asst.) Bact., Hyg.*
Chas. P. Halligan, B. S., *(Asst.) Hort.*
F. H. Sanford, B. S., *(Asst.) For.*
Arthur J. Clark, A. B., *(Asst.) Chem.*
Caroline L. Holt, *Instr. Draw.*
Louise Freyhofer, B. A., *Instr. Music.*
Thomas Gunson, *Instr. Hort.; Supt. of Grounds.*
Norma L. Gilchrist, A. B., *Instr. Engl.*
W. B. Liverance, B. S., *Instr. Dairying.*
Charles Henley, *Clerk to Pres., Editor M. A. C. Record.*
Albert E. Jones, B. A., *Instr. Math.*
Wm. A. Robinson, A. B., S. T. B., *Instr. Engl.*
Victor E. Wilson, M. E., *Instr. Draw. and Design.*
Kate M. Coad, B. S., *Instr. Dom. Art.*
Arthur E. Fish, A. B., *Instr. Engl.*
Ward Giltner, M. S., D. V. M., *Research Asst. in Bact.*
Walter E. Hawkes, A. B., *Instr. Math.*
Herman Hensel, A. B., *Instr. Engl. and German.*
William E. Laycock, *Instr. Phys.*
Shepherd Leffler, A. B., *Instr. Hist.*
Ward H. Parker, B. S., *Instr. Chem.*
Mrs. Lillian L. Peppard, *Instr. Dom. Sci. and Art.*
M. F. Johnson, B. S., *Instr. Math.*
Geo. D. Shafer, PH. D., *Research Asst. in Ent.*
Merrill A. Yothers, B. S., *Instr. Ent.*
Orestes I. Gregg, B. S., *Instr. Hort.*
Pearl McDonald, M. A., *Instr. Dom. Sci.*
Chas. W. Brown, B. S., *Instr. Bact.*
W. L. Lodge, B. S., M. A., *Instr. Phys.*
Mrs. Minnie Hendrick, A. M., *Instr. Hist.*
Leslie N. Cullom, A. M., *Instr. Engl.*
Rose M. Taylor, A. B., *Instr. Bot.*
Geo. A. Brown, B. S., *Instr. Animal Husb.*
Lewis S. Fuller, B. S., *Instr. Math.*
Mabel Long, *Instr. Phys. Culture.*
Helen I. Michaelides, *Instr. French, Engl*
Hector Macpherson, M. S., *Instr. Econ.*
Margaret B. Dupee, B. S., *Instr. Bot.*
Herbert E. Marsh, B. S., *Instr. Phys.*
Benj. B. Roseboom, jr., B. S., *Instr. Zool.*
Isabel P. Snelgrove, *Instr. Draw.*
Mrs. G. A. Robson, *Instr. Engl., German.*
Carl E. Hopphan, B. S., *Instr. Math.*
E. E. Beighle, B. S., *Instr. Math.*
Stanley E. Crow, B. S., *Instr. Math.*
Lloyd C. Emmons, B. S., *Instr. Math.*
J. E. Robertson, B. S., *Instr. Math.*
Frederick A. Burt, B. S., *Instr. Zool.*
Chas. C. Cobb, B. S., *Instr. Draw.*
C. M. Hargrave, B. S., *Instr. Chem.*
H. L. Kempster, B. S., *Instr. Poultry Husb.*
H. H. Musselman, B. S., *Instr. Farm Mech.*
W. Eugene Sloat, *Instr. Engl.*
C. H. Spurway, B. S., *Instr. Soil Phys.*
Max. L. Tower, B. S., *Instr. Chem.*
Geo. F. Williamson, A. B., *Instr. Engl.*
C. L. Wuebker, A. B., *Instr. Engl., German.*
Roscoe G. Stott, A. B., *Instr. Engl.*
Richard de Zeeuw, PH. D., *Instr. Bot.*
Harold S. Osler, B. S., *Instr. Zool.*
Zae Northrup, B. S., *Asst. in Bact.*
Mary L. Smith, PH. D., *Asst. in Bact.*
Belle Farrand, B. S., *Asst. in Bact.*
Rosemond H. Kedzie, B. S., *Asst. in Dom. Art.*
R. S. Hudson, B. S., *Foreman of College Farm.*
Agnes E. Crumb, *Asst. Libr.*
F. W. Raven, *Field Agt. in charge of Ext. Work.*
O. K. White, B. S., *Field Agt., Hort. Ext Work.*
A. R. Potts, *Field Agt., Soil and Crop Ext. Work.*

Experiment Station of Michigan State Agricultural College, *East Lansing.*

Department of Michigan State Agricultural College, under the control of the State Board of Agriculture.

STATION STAFF.

Robert S. Shaw, B. S. A., *Dir.*
C. E. Marshall, Ph. D., *Sci. and V. Dir.; Bact.*
W. J. Beal, D. Sc., Ph. D., *Bot.*
L. R. Taft, M. S., *Consulting Hort.*
R. H. Pettit, B. S. Agr., *Ent.*
A. J. Patten, B. S., *Chem.*
H. J. Eustace, B. S., *Hort.*
J. A. Jeffery, B. S., *Soil Physicist.*
A. M. Brown, A. B., *Sec., Treas.*
L. M. Hurt, D. V. M., *Consulting Vet.*
C. P. Halligan, B. S., *Asst. Hort.*
Otto Rahn, Ph. D., *Asst. Bact.*
J. B. Dandeno, Ph. D., *Asst. Bot.*
Ward Giltner, M. S., D. V. M., *Research Asst. in Bact.*
Chas. S. Robinson, M. S., *Research Asst. in Chem.*
G. D. Shafer, Ph. D., *Research Asst. in Ent.*
A. C. Anderson, B. S., *Asst. Dairy Husb.*
C. W. Brown, B. S., *Asst. Bact.*
F. A. Spragg, M. S., *Asst. in Farm Crops (Plant Breeding).*
Miss Z. Northrup, B. S., *Asst. Bact.*
Mary L. Smith, Ph. B., *Asst. Bact.*
M. A. Yothers, B. S., *Asst. Ent.*
Mrs. Linda E. Landon, *Libr.*
Leo M. Geismar, *in charge of Substa., Chatham.*
F. A. Wilken, *in charge of Substa., South Haven.*

MINNESOTA.

College of Agriculture of the University of Minnesota, *St. Anthony Park, St. Paul.*

GOVERNING BOARD.

Board of Regents: John Lind (*Pres.*), *Minneapolis;* Cyrus Northrop (*ex officio*), *Minneapolis;* Gov. A. O. Eberhart (*ex officio*), *St. Paul;* C. G. Schulz (*State Supt. of Public Instr., ex officio*), *St. Peter;* Thomas Wilson, *St. Paul;* A. E. Rice, *Willmar;* B. F. Nelson, *Minneapolis;* Pierce Butler, *St. Paul;* C. A. Smith, *Minneapolis;* S. M. Owen, *Minneapolis;* W. J. Mayo, *Rochester;* H. B. Hovland, *Duluth;* C. D. Decker (*Sec.*), *Minneapolis.*

COURSES OF STUDY.

The college courses require four years for completion and lead to the degrees of B. S. in Agr., B. S. in For., and B. S. in Home Econ. There is also a secondary school of agriculture, with a course requiring three years of six months each for completion, a two-year course in industrial and agricultural education for the preparation of teachers for high schools, a two-year normal course in home economics, a six weeks' summer school of forestry, a special lecture course of four weeks for farmers, a dairy course of four weeks, and a four weeks' school of traction engineering. To secure a dairy certificate the student must have one season's practice in a creamery or cheese factory before and another after his work at the dairy school. A summer school for teachers gives instruction in agricultural subjects.

BOARD OF INSTRUCTION.

The College of Agriculture.

Cyrus Northrop, LL. D., *President of the University.*

A. F. Woods, M. A., *Dean of the College.*
Samuel B. Green, B. S., *Hort., For.*
T. L. Haecker, *Dairy Husb. and Animal Nutrition.*
M. H. Reynolds, B. S., M. D., D. V. M., *Vet. Med. and Surgery.*
Andrew Boss, *Agr. and Animal Husb.*
Frederick L. Washburn, M. A., *Ent.*
Ralph Hoagland, B. S., *Agr. Chem., Soils.*
Edward Sigerfoos, Ph. B., LL. B., Capt., U. S. A., *Mil. Sci. and Tactics.*
E. M. Freeman, Ph. D., *Veg. Path., Bot.*
John T. Stewart, B. S. in C. E., *Agr. Engin., Phys.;* (*Actg.*) *Farm Mech.*
D. D. Mayne, *Agr. Pedag.; Prin. School of Agr.*
Fannie C. Boutelle, *Dom. Econ.; Preceptress.*
Coates P. Bull, B. Agr., (*Asst.*) *Agr.*
E. G. Cheyney, A. B., (*Asst.*) *For.*
D. A. Gaumnitz, M. S. Agr., (*Asst.*) *Animal Husb.*

Robert C. Lansing, M. A., (*Asst.*) *Engl.*
C. C. Lipp, D. V. M., (*Asst.*) *Vet. Med. and Surgery.*
Edward K. Slater, (*Asst.*) *Dairy Husb.*
J. P. Wentling, M. A., (*Asst.*) *For.*
Margaret J. Blair, *Instr. Dom. Art.*
Alvah M. Bull, *Instr. Draw.*
Mary L. Bull, *Instr. Dom. Sci.*
LeRoy Cady, B. S. in Agr., *Instr. Hort.*
Henrietta Clopath, *Instr. Free-hand Draw.*
Thos. P. Cooper, B. S. in Agr., *Instr. Agr.*
J. M. Drew, *Registrar; Instr. Blacksm., Poultry.*
J. L. Edmunds, B. S. A., *Instr. Animal Husb.*
Wm. H. Frazier, B. S., *Instr. Soils.*
Geo. P. Grout, B. S., *Instr. Dairy Husb.*
Avis C. Hall, *Instr. Dom. Art.*
W. F. Handschin, *Instr. Animal Husb.*
D. B. Howell, Ph. B., *Instr. Animal Nutrition.*
A. R. Kohler, B. S. A., *Instr. Hort.*
May McDonald, B. S., *Instr. Dom. Sci.*
Karl A. Machetanz, B. A., LL. B., *Dir. of Gymnasium, Coach.*
Martha B. Moorhead, M. D., *Lect. in Dom. Sci.*
J. L. Mowry, *Instr. Farm Structures and Farm Mech.*
W. S. Oswald, M. S., *Instr. Bot.*
C. A. Pyle, B. S., D. V. M., *Instr. Vet. Sci.*
H. B. Roe, B. S. in E., *Instr. Math., Engin.*
A. G. Ruggles, B. S. A., M. A., *Instr. Ent.*
Juniata L. Shepperd, M. A., *Instr. Dom. Sci.*
Anna M. Smith, *Libr.*
J. A. Vye, *Instr. Farm Accts.*
H. B. White, B. S. A., *Instr. Carpentry.*
Grace B. Whitridge, *Instr. Phys. Training.*
A. D. Johnston, *Instr. Blacksm.*
D. J. Lane, *Instr. Poultry.*
Rodney M. West, B. A., *Instr. Agr. Chem.*
Cornelia Kennedy, B. A., *Instr. Agr. Chem.*
Mary Matthews, *Instr. Dom. Art.*
A. C. Arny, B. S. in Agr., *Asst. in Agr.*

The School of Agriculture.

Cyrus Northrop, LL. D., *President.*

A. F. Woods, M. A., *Dean.*
D. D. Mayne, *Prin.; Practicums.*
J. A. Vye, *Farm Accts.; Sec., Treas.*
J. M. Drew, *Registrar; Instr. Poultry.*
Fannie C. Boutelle, *Preceptress; Social Culture.*
Anna M. Smith, *Libr.*
Andrew Boss, *Agr., Animal Husb.*
J. T. Stewart, B. S. in C. E., *Agr. Engin., Phys., Farm Structures and Farm Mech.*
T. L. Haecker, *Dairy Husb., Animal Nutrition.*
Margaret J. Blair, *Sew., Household Art.*
Juniata L. Shepperd, M. A., *Cooking, Laundering, Home Econ.*
R. C. Lansing, M. A., *Engl.*
F. L. Washburn, M. A., *Zool., Ent.*
S. B. Green, B. S., *Hort., For.*
E. M. Freeman, Ph. D., *Veg. Path., Bot.*
Ralph Hoagland, B. S., *Agr. Chem., Soils.*
M. H. Reynolds, B. S., M. D., D. V. M., *Vet. Sci.*
C. C. Lipp, D. V. M., *Comparative Physiol.*
Edward Sigerfoos, Ph. B., LL. B., Capt., U. S. A., *Mil. Sci. and Tactics.*
C. P. Bull, B. Agr., *Asst. in Agr.*
A. D. Wilson, B. S. in Agr., *Asst. in Agr.*
T. P. Cooper, B. S. in Agr., *Asst. in Agr.*
R. M. West, B. A., *Asst. in Agr. Chem.*
Agnes Ericson, *Asst. in Agr. Chem.*
Cornelia Kennedy, B. A., *Asst. in Agr. Chem.*
Walter L. Badger, *Asst. in Agr. Chem.*
A. L. Ewing, M. S., *Asst. in Agr. Phys.*
D. A. Gaumnitz, M. S. Agr., *Asst. in Animal Husb.*
J. L. Edmunds, B. S. A., *Asst. in Animal Husb.*
W. F. Handschin, *Asst. in Animal Husb.*
A. J. McGuire, B. Agr., *Asst. in Dairying.*
G. P. Grout, B. S., *Asst. in Dairy Husb.*
E. K. Slater, *Asst. in Dairy Husb.*
Avis C. Hall, *Asst. in Sew.*
Greta Smith, *Asst. in Sew.*
Mary L. Bull, *Asst. in Cooking, Laundering.*
May McDonald, B. S., *Asst. in Cooking.*
Estelle Cook, *Asst. in Engl.*
Ethel E. Bush, B. A., *Asst. in Engl.*
A. G. Ruggles, B. S. A., M. A., *Asst. in Ent.*
Alvah M. Bull, *Asst. in Draw., Farm Buildings.*
A. D. Johnston, *Asst. in Blacksm.*
Thomas Sewall, *Asst. in Draw.*
H. B. White, B. S. A., *Asst. in Carpentry.*
J. L. Mowry, *Asst. in Mech. Practicums.*
LeRoy Cady, B. S. in Agr., *Asst. in Hort.*
E. G. Cheyney, A. B., *Asst. in For.*
A. R. Kohler, B. S. A., *Asst. in Veg. Gard.*
J. P. Wentling, M. A., *Asst. in For.*
W. H. Frazier, B. S., *Asst. in Soils.*
W. L. Oswald, M. S., *Asst. in Agr. Bot.*
A. C. Arny, B. S. in Agr., *Asst. in Agr.*
C. A. Pyle, B. S., D. V. M., *Asst. in Vet. Sci.*
Grace B. Whitridge, *Phys. Training.*
Karl A. Machetanz, B. A., LL. B., *Hist.; Dir. of Gymnasium.*
D. B. Howell, Ph. B., *Math.*
Martha B. Moorhead, M. D., *Lect. in Dom. Hyg.*
Mary L. Coffin, *Music.*
H. B. Roe, B. S. in E., *Math.*
Gertrude V. Collins, *Asst. in Farm Accts.*

Agricultural Experiment Station of the University of Minnesota, *St. Anthony Park, St. Paul.*

Department of University of Minnesota, under the control of the Board of Regents.

STATION STAFF.

A. F. Woods, M. A., *Dir.*
S. B. Green, B. S., *Hort., For.*
T. L. Haecker, *Dairying, Animal Nutrition.*
M. H. Reynolds, M. D., V. M., *Vet.*
Andrew Boss, *Agr., Animal Husb.*
F. L. Washburn, M. A., *Ent.*
E. M. Freeman, Ph. D., *Bot., Veg. Path.*
Ralph Hoagland, B. S., *Agr. Chem., Soils.*
C. C. Lipp, D. V. M., *Asst. Vet.*
C. P. Bull, B. Agr., *Asst. Agr.*
D. A. Gaumnitz, M. S. Agr., *Asst. Animal Husb.*
A. D. Wilson, B. S. in Agr., *Asst. Agr.; in charge of Farmers' Insts. and Ext. Work.*
T. P. Cooper, B. S. in Agr., *Asst. Agr.*
LeR. Cady, B. S. in Agr., *Asst. Hort.*
E. G. Cheyney, A. B., *Asst. For.*
A. G. Ruggles, B. S. A., M. A., *Asst. Ent.*
W. H. Frazier, B. S., *Asst. Chem.*
A. C. Arny, B. S. in Agr., *Asst. in Agr.*
W. F. Handschin, *Asst. Animal Husb.*
A. R. Kohler, B. S. A., *Asst. Hort.*
J. A. Vye, *Sec.*
R. M. West, B. A., *Asst. Chem.*
Wm. Robertson, B. S., *Supt. Substa., Crookston.*
A. J. McGuire, B. Agr., *Supt. Substa., Grand Rapids.*
Charles Haralson, *Supt. Fruit Breeding Farm, Excelsior.*
Fred Haralson, *Hort. Foreman.*

MISSISSIPPI.

Mississippi Agricultural and Mechanical College, *Agricultural College.*[a]

GOVERNING BOARD.

Board of Trustees: Gov. E. F. Noel (*ex officio Pres.*), *Jackson;* A. J. Moore (*Sec.*), *Agricultural College;* G. R. Edwards (*Treas.*), *Jackson;* P. W. Maer, *Columbus;* T. L. Wainwright, *Stonewall;* A. S. Meharg, *Grenada;* J. C. Bradford, *Biloxi;* W. A. Dickson, *Centerville;* J. N. Powers (*ex officio*), *Jackson;* A. T. Dent, *Macon;* J. W. Norment, *Starkville;* J. C. Hardy (*Pres. of College*), *Agricultural College;* Douglas Robinson, *Sidon;* J. M. Coen, *Mizpah;* R. L. Tucker, *Chulahoma;* Z. D. Davis, *Jackson;* J. M. White, *West Point.*

COURSES OF STUDY.

There are four four-year courses, viz: Agricultural, engineering (including mechanical, electrical, civil, and mining engineering), textile, and industrial pedagogy (B. S.); post-graduate courses, a preparatory course, practical working boys' course, two-year courses in agriculture, mechanical engineering, electrical engineering, and textile industry, respectively, a ten weeks' course in agriculture, short summer courses in agriculture, and a summer school for teachers.

BOARD OF INSTRUCTION.

John C. Hardy, A. M., LL. D., *President.*

Wm. H. Magruder, M. A., LL. D., *V. Pres.; Engl.*
Washington L. Hutchinson, M. S., *Dir. School of Agr.*
Alexander B. McKay, B. S., *Hort.*
John C. Herbert, M. S., *Hist., Civics.*
Wm. F. Hand, Ph. D., *Chem.* (*State Chem.*).
Edward R. Lloyd, M. S., *Agr.; in charge of Farmers' Insts. and Ext. Work.*
David C. Hull, M. S., *Indus. Pedag.*
Wm. N. Logan, Ph. D., *Geol., Min.*
G. S. Goodale, Capt., U. S. A., *Mil. Sci. and Tactics.*
Josephus S. Moore, M. S., *Dairy Husb.*
R. P. Hibbard, Ph. D., *Bact.; Plant Path.*
Peter P. Garner, M. S., *Prin. Prep. Dept.*
Archibald Smith, *Animal Husb.*
Geo. L. Clothier, M. S., M. F., *Bot., For.*
James V. Bowen, Ph. B., *Foreign Lang.*
Henry L. Noel, B. S., M. D., *Anat., Physiol.; Surgeon.*
James Lewis, B. S. A., M. D. C., *Vet. Sci.*
J. O. Morgan, Ph. D., *Agron.*
R. W. Harned, B. S. Agr., (*Actg.*) *Zool. Ent.*
Fitz-John Weddell, B. S., (*Assoc.*) *Engl.*
Christopher R. Stark, B. S., (*Assoc.*) *Math.*

[a] Telegraph address, *Starkville.* Express and post-office address, *Agricultural College.* Freight address, *A. and M. College Station.*

Jack P. Montgomery, PH. D., *(Assoc.) Chem.*
Frank C. Bolton, B. S., *(Assoc.) Phys.*
James R. Ricks, M. S., *(Assoc.) Agron.*
H. C. Thompson, B. S., *(Asst.) Hort.*
F. M. Darnall, B. A., *(Asst.) Engl.*
Hugh Critz, B. S., *(Asst.) Math.*
James S. Wallace, B. S., *Instr. Math.*
Andrew M. Maxwell, *Instr. Bookkeeping.*
Albert L. Love, B. S., *Instr. Engl.*
Thos. F. Jackson, B. S., *Instr. Prep. Dept.*
F. D. Mellen, A. B., M. S., *Instr. Engl.*
James E. McKell, B. S., *Instr. Prep. Dept.*
Matthew L. Freeman, M. S., *Instr. Draw.*
V. W. Bragg, *Instr. Wood Shop, Manual Training.*
James P. Kerr, *Instr. Poultry Husb.*
Harold L. McGeorge, B. S., *Asst. in Chem.*
Irwin D. Sessums, B. S., *Asst. in Chem.*
Howard S. Chilton, B. S., *Asst. in Chem.*
M. F. Caglon, B. S. A., *Asst. in Chem.*
Marvin Gieger, B. S., PH. B., *Asst. in Chem.*
Wilkinson Stark, B. S., *Asst. in Chem.*
Hugh W. Stallworth, B. S., *Asst. in Chem.*
E. C. McInnis, B. S., *Asst. in Chem.*
Perley B. Monosmith, *Florist.*
T. W. Davis, B. S., *Libr.*
W. W. Routten, *Dir. of Band.*
Chas. I. Bray, M. S., *Dairy Herdsman.*
John C. Kean, *Herdsman Animal Husb. Dept.*

1. **Mississippi Agricultural Experiment Station,** *Agricultural College.*
2. **McNeill Branch Experiment Station,** *McNeill.*
3. **Delta Branch Experiment Station,** *Stoneville.*
4. **Holly Springs Branch Experiment Station,** *Holly Springs.*

Department of Mississippi Agricultural and Mechanical College, under the control of the Board of Trustees.

STATION STAFF.

Mississippi Agricultural Experiment Station, *Agricultural College.*

W. L. Hutchinson, M. S., *Dir.*
J. A. McLean, B. A., B. S. A., *Animal Husb.*
Wm. R. Perkins, M. S., *Agron.*
J. S. Moore, M. S., *Dairy Husb.*
A. B. McKay, B. S., *Hort.*
R. P. Hibbard, PH. D., *Bact., Plant Path.*
G. L. Clothier, M. S., M. F., *For., Bot.*
James Lewis, B. S. A., M. D. C., *Vet.*
J. P. Kerr, *Poultryman.*
R. W. Harned, B. S., AGR., *Ent.*
H. C. Thompson, B. S., *Asst. Hort.*
A. J. Moore, B. S., *Treas.*
H. M. Parker, B. S., *Farm Mgr.*

McNeill Branch Experiment Station, *McNeill.*

W. L. Hutchinson, M. S., *Dir.*
E. B. Ferris, M. S., *Asst. Dir. in charge.*
John Phares, *Foreman of Farm.*

Delta Branch Experiment Station, *Stoneville.*

W. L. Hutchinson, M. S., *Dir.*
J. W. Fox, M. S., *Asst. Dir. in charge.*
W. W. Fox, B. S., *Foreman of Farm.*

Holly Springs Branch Experiment Station, *Holly Springs.*

W. L. Hutchinson, M. S., *Dir.*
C. T. Ames, B. S., *Asst. Dir. in charge.*
T. E. Murphey, *Foreman of Farm.*

Alcorn Agricultural and Mechanical College, *Alcorn.*

GOVERNING BOARD.

COURSES OF STUDY.

The courses of study are as follows: Three-year industrial, four-year scientific (B. S.), two-year preparatory, and three-year primary.

BOARD OF INSTRUCTION.

L. J. Rowan, B. S., *President.*

J. R. Ramsey, B. S., *Math.*
R. A. Gordon, B. S., M. D., *Nat. Sci.*
J. H. Moseley, B. S., *Gen. Hist., Moral Sci., Phys. Geog., Met.*
E. H. Patton, B. S., *Agr.; Farm Supt.*
H. T. Tanner, *Hort., Dairying and Truck Gard.*
J. C. Bullen, Ph. B., *Engl.*
J. H. Powell, B. S., *(Asst.) Math.*
P. S. Bowles, B. S., *(Asst.) Agr.; Dir. Expt. Farm.*
J. T. Hall, B. S., *(Asst.) Engl.*
A. D. Snodgrass, *Chaplain; (Asst.) Nat. Sci.*
Pauline Jackson, *Matron; Laundering.*
Mrs. Sadie H. Miller, *Dom. Sci.*
Alice G. Laws, *Sew.*
James McClure, *Sec., Treas.*
Victoria Whitaker, *Nurse Training.*

MISSOURI.

College of Agriculture and Mechanic Arts of the University of Missouri, *Columbia.*

GOVERNING BOARD.

Board of Curators: J. V. C. Karnes (*Pres.*), *Kansas City;* D. R. Francis (*V. Pres.*), *St. Louis;* J. G. Babb (*Sec.*), *Columbia;* R. B. Price (*Treas.*), *Columbia;* B. H. Bonfoey, *Unionville;* J. C. Parrish,* *Vandalia;* P. E. Burton, *Joplin;* S. L. Baysinger, *Rolla;* C. B. Rollins,* *Columbia;* T. J. Wornall, *Liberty;* Chas. E. Yates,* *Sedalia.*

COURSES OF STUDY.

In the College of Agriculture the four-year courses lead to the degrees of B. S. in agriculture and B. S. in home economics. There is also a winter course in general agriculture extending through two years of fourteen weeks each, a summer school for teachers, and a farmers' week.

BOARD OF INSTRUCTION.

Albert Ross Hill, Ph. D., LL. D., *President of the University; Educational Psychology.*

Frederick B. Mumford, M. S., *Dean; Animal Husb.*
Paul Schweitzer, Ph. D., LL. D., *Agr. Chem. Emeritus.*
Edward A. Allen, Litt. D., *Engl., Lit.*
John W. Connaway, D. V. S., M. D., *Vet. Sci.*
John C. Whitten, Ph. D., *Hort.*
Wm. G. Brown, Ph. D., *Chem.*
Curtis F. Marbut, B. S., M. A., *Geol., Soil Survey.*
George Lefevre, Ph. D., *Zool.*
Merritt F. Miller, M. S. A., *Agron.*
Oscar M. Stewart, Ph. D., *Phys.*
Herschel Tupes, Capt., U. S. A., *Mil. Sci.; Comdt. of Cadets.*
C. H. Eckles, B. Agr., M. S., *Dairy Husb.*
Sidney Calvert, B. S., A. M., *Org. Chem.*
George Reeder,[a] *Dir. Weather Bureau; Climat.*
P. F. Trowbridge, Ph. D., *Agr. Chem.*
C. Stuart Gager, Ph. D., *Bot.*
Winterton C. Curtis, Ph. D., *Zool.*
Walter L. Howard, Ph. D., *Hort.*
R. H. Emberson, B. S., *Ext. Work in Rural Schools.*
Edna D. Day, Ph. D., *(Asst.) in charge of Home Econ.*
R. H. Shaw,[a] B. S., *(Asst.) Dairy Husb.*
Geo. M. Reed, Ph. D., *(Asst.) Bot.*
E. A. Trowbridge, B. S. A., *(Asst.) Animal Husb.*
C. A. Willson, B. S., *Instr. Animal Husb.*
Louise Stanley, B. S., M. A., *Instr. Home Econ.*
Harold D. Hughes, M. S. A., *Instr. Agron.*
Lee S. Backus, D. V. M., *Instr. Vet. Sci.*
Chas. K. Francis, Ph. B., A. M., *Instr. Agr. Chem.*
W. H. Chandler, M. S., *Asst. in Hort.*
John M. Evvard, M. S., *Asst. in Animal Husb.*
A. E. Perkins,[a] *Asst. in Dairy Husb.*
L. G. Rinkle, B. S., *Asst. in Dairy Husb.*
C. B. Hutchison, B. S. A., *Asst. in Agron.*
Frank H. Demaree, B. S. A., *Asst. in Agron.*
F. W. Woodman, M. S., *Asst. in Agr. Chem.*
W. T. Bovie, A. M., *Asst. in Bot.*
Ralph J. Carr, B. S., *Asst. in Animal Husb.*
Chas. R. Moulton, M. S., *Asst. in Agr. Chem.*
L. D. Haigh, M. S., *Asst. in Agr. Chem.*
R. E. Hundertmark, B. S. A., *Asst. in Dairy Husb.*
Louis O. Kunkel, B. S., *Asst. in Bot.*
C. W. Hetherington, A. B., *Phys. Training.*
Caroline Rumbold, B. L., M. A., *Asst. in Bot.*
H. E. McNatt, B. S. A., *Asst. in Dairy Husb.*
Chas. T. Dearing, B. S. A., *Asst. in Hort.*
Carl A. Schwartze, B. S. A., *Asst. in Bot.*
Jos. B. Latshaw, B. S. A., *Asst. in Vet. Sci.*
E. W. Rusk, B. S. A., *Asst. in Animal Husb.*
Fred S. Putney, *Asst. to Dean.*
Irvin Switzler, *Registrar.*
Arthur Rhys, B. S., *Herdsman.*

[a] In the service of the U. S. Department of Agriculture.

Missouri Agricultural College Experiment Station, *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of Missouri, under the control of the Board of Curators.

STATION STAFF.

F. B. Mumford, M. S., *Dir.; Animal Husb.*
Paul Schweitzer, Ph. D., LL. D., *Agr. Chem. Emeritus.*
J. C. Whitten, Ph. D., *Hort.*
J. W. Connaway, D. V. S., M. D., *Vet.*
C. H. Eckles, B. Agr., M. S., *Dairying.*
M. F. Miller, M. S. A., *Agron.*
C. F. Marbut, B. S., M. A., *Soil Survey.*
Geo. Reeder,[a] *Dir. Weather Bureau.*
P. F. Trowbridge, Ph. D., *Chem.*
W. L. Howard, Ph. D., *Asst. Hort.*
C. S. Gager, Ph. D., *Bot.*
G. M. Reed, Ph. D., *Asst. Bot.*
R. H. Shaw,[a] B. S., *Asst. Dairyman.*
W. H. Chandler, M. S., *Asst. Hort.*
E. A. Trowbridge, B. S. A., *Asst. Animal Husb.*
J. M. Evvard, M. S., *Asst. Animal Husb.*
C. A. Willson, B. S., *Asst. Animal Husb.*
A. E. Perkins,[a] B. S., *Asst. Dairy Chem.*
H. D. Hughes, M. S. A., *Asst. Agron.*
L. S. Backus, D. V. M., *Asst. Vet.*
L. G. Rinkle, B. S., *Asst. Dairyman.*
C. R. Moulton, M. S., *Asst. Chem.*
C. B. Hutchison, B. S. A., *Asst. Agron.*
L. D. Haigh, M. S., *Asst. Chem.*
F. W. Woodman, M. S., *Research Asst. Chem.*
C. K. Francis, Ph. B., A. M., *Research Asst. Chem.*
Frank H. Demaree, B. S. A., *Asst. Agron.*
W. T. Bovie, A. M., *Asst. Bot.*
R. J. Carr, B. S., *Asst. Animal Husb.*
H. E. McNatt, B. S. A., *Asst. Dairy Husb.*
C. T. Dearing, B. S. A., *Asst. Hort.*
A. A. Jones, B. S. A., *Asst. Agr. Chem.*
E. W. Rusk, B. S. A., *Asst. Animal Husb.*
Arthur Rhys, B. S., *Herdsman.*
John Schnabel, *Gard.*
J. G. Babb, M. A., *Sec.*
R. B. Price, B. S., *Treas.*
F. S. Putney, *Asst. to Dir.*

Missouri State Fruit Experiment Station, *Mountain Grove.*

GOVERNING BOARD.

Trustees: C. B. McAfee (*Pres.*), *Springfield;* Joe Knoerle (*Sec.*), *West Plains;* W. C. Paynter (*Treas.*), *Koshkonong.*

STATION STAFF.

Paul Evans, *Dir.*
F. M. Rolfs, M. S., *Veg. Path.*
E. P. Taylor, B. S., *Ent.*
A. M. Swartwout, *Field Asst.*

Lincoln Institute, *Jefferson City.*

GOVERNING BOARD.

Board of Regents: W. F. Chamberlain (*Pres.*), *Hannibal;* A. Ross Hill (*V. Pres.*), *Columbia;* S. B. Cook (*Treas.*), *Jefferson City;* H. A. Gass (*State Supt. of Public Schools, ex officio*), *Jefferson City;* Thos. S. Mosby, *Jefferson City;* N. C. Burch (*Sec.*), *Jefferson City;* Hugh K. Rea, *Carrollton;* Richard Smith, *Fulton;* E. S. Emery, *Ely.*

COURSES OF STUDY.

This institution has the following departments: College (four-year course leading to degree of B. A.), college preparatory, normal (two and four-year courses), normal preparatory (three years), industrial, agricultural, and domestic. There is also a summer school of seven weeks.

BOARD OF INSTRUCTION.

Benjamin Franklin Allen, A. M., LL. D., *President; Ethics, Psychology.*

Grant S. Murray, A. B., *Phys. Sci.*
Jonas Moten, M. A., *Math.*
C. S. Woodard, B. S. A., *Biol., Agr.*
Mrs. Josephine S. Yates, A. M., *Engl., Draw.*
Mrs. Anna J. Cooper, A. M., *Lat., Greek.*
A. T. Walker, B. S., *Pedag.*
E. W. Houston, A. B., *Asst. in Math.*
Wm. H. Harrison, *Asst. in Engl.*
Carrie M. Carney, *Vocal Music.*
James P. English, *Farm Supt.*
R. Mabel Moorman, *Instr. Dom. Art.*
Sarah A. E. Potts, *Instr. Dom. Sci.*
Mrs. J. R. McDowell, *Matron for Boys.*
Lillian Johnson, *Matron for Girls; in charge of Laundry.*

[a] In the service of the U. S. Department of Agriculture.

MONTANA.

Montana Agricultural College, *Bozeman*.

GOVERNING BOARD.

Executive Board: James M. Hamilton[*] (*Pres.*), *Bozeman;* Walter S. Hartman,[*] *Central Avenue, Bozeman;* J. H. Baker,[*] *Commercial National Bank, Bozeman;* George Cox (*Sec.-Treas.*), *Bozeman.*

COURSES OF STUDY.

The following courses of study are given: Four-year courses in civil, electrical, and mechanical engineering, home science, chemistry, biology, history-literature, mathematics-physics, pharmacy, agronomy, animal industry and dairying, horticulture, and forestry, leading to the degree of B. S.; four-year course in art and music; four-year preparatory and three-year agricultural courses; two-year course in pharmacy (Ph. C.); one-year course in household economics, and short winter courses in creamery work (four weeks), dairying, stock judging, and domestic science (one week).

BOARD OF INSTRUCTION.

James M. Hamilton, M. S., *President; Philosophy and Economics.*

Mrs. F. E. Marshall, *Art.*
Wm. F. Brewer, A. M., *Engl., Lat.*
Aaron H. Currier, A. M., *French, German.*
Lilla A. Harkins, M. S., *Dom. Sci.*
Robert A. Cooley, B. S., *Ent.*
Wm. D. Tallman, B. S., *Math.*
Frederick B. Linfield, B. S. A., *Agr.*
Wm. M. Cobleigh, A. M., *Chem.*
Wm. J. Elliott,[a] B. S. A., *Dairying.*
Alfred Atkinson, B. S. A., *Agron.*
O. B. Whipple, B. S., *Hort.*
Robert W. Clark, B. Agr., *Animal Indus.*
Walter J. Taylor, D. V. M., *Vet. Sci.*
F. S. Cooley, B. S., *Dir. of Farmers' Insts.*
Edmund Burke, B. S., (*Asst.*) *Chem.*
Deane B. Swingle, M. S., *Bot., Bact.*
Chas. S. Dearborn, B. S., *Mech. Arts.*
M. Herrick Spaulding, A. M., (*Asst.*) *Zool.*
Robert D. Kneale, C. E., *Civil Engin.*
Mary A. Cantwell, *Prin. Prep. Dept.; Instr. Engl., Math.*
Helen R. Brewer, A. B., *Instr. Hist., Lat.*
Edward A. Duddy, A. M., *Public Speaking.*
Florence Ballinger, *Instr. Sew.*
Frank W. Ham, M. S., *Instr. Phys.*
F. C. Snow, B. S., *Asst. in Civil Engin.*
Frieda Bull, M. S., *Asst. in Math.*
Florence Brown, B. S., *Asst. in Dom. Sci.*
Wm. F. Schoppe, B. S. A., *Instr. Poultry Husb.*
H. P. Griffin, B. S. A., *Asst. in Animal Husb.*
H. F. Patterson, B. S. A., *Asst. in Agron.*
Mrs. Edna Gage, *Asst. in Art.*
Mrs. Mary K. Winter, *Libr.*

Montana Agricultural Experiment Station, *Bozeman*.

Department of the Montana Agricultural College, under the control of the Executive Board.

STATION STAFF.

F. B. Linfield, B. S. A., *Dir.*
R. A. Cooley, B. S., *Ent.*
O. B. Whipple, B. S., *Hort.*
W. J. Elliott,[a] B. S. A., *Dairyman.*
Alfred Atkinson, B. S. A., *Agron.*
R. W. Clark, B. Agr., *Animal Indus.*
Edmund Burke, B. S., *Chem.*
D. B. Swingle, M. S., *Bot., Bact.*
W. J. Taylor, D. V. M., *Vet.*
J. B. Nelson, *Supt. Dry Farm Work.*
R. M. Pinckney, B. S., A. M., *Asst. Chem.*
L. F. Gieseker, B. S., *Asst. Agron.*
H. F. Patterson, B. S. A., *Asst. Agron.*
W. W. Spain, B. S., *Asst. Agr. Engin.*
H. E. Morris, B. S., *Asst. Bot.*
H. P. Griffin, B. S. A., *Asst. Animal Indus.*
W. F. Schoppe, B. S. A., *Asst. Poultryman.*
Fritz Knorr,[b] *Supt. Huntley Substa.*
John Stephens,[b] B. S., *Supt. Fergus Co. Substa.*

NEBRASKA.

The College of Agriculture of the University of Nebraska, *Lincoln*.

GOVERNING BOARD.

Regents of the University: Chas. S. Allen (*Pres.*), *Lincoln;* Wm. G. Whitmore,[*] *Valley;* Victor G. Lyford,[*] *Falls City;* Chas. B. Anderson, *Crete;* Jas. S. Dales (*Sec.*), *Lincoln;* George Coupland, *Elgin;* Frank L. Haller,[*] *Omaha.*

[a] Resigned, to take effect January 1, 1910.
[b] In cooperation with the U. S. Department of Agriculture.

COURSES OF STUDY.

The college courses consist of four general groups—the general agricultural group, the technical agricultural group, the technical forestry group, and the home economics group (B. S.). A three years' vocational course in agriculture and home economics is offered in a secondary school, which is in session for six months each year. A seven weeks' winter course in agriculture is also offered in this school. The teachers' college offers a one-year course in agriculture and in home economics and manual training and a summer school for teachers (six weeks).

BOARD OF INSTRUCTION.[a]

Samuel Avery, Ph. D., *Chancellor of the University.*

Edgar A. Burnett, B. S., *Dean College of Agr.*
Charles E. Bessey, Ph. D., LL. D., *Head Dean in Univ.; Head Bot.*
Lawrence Bruner, B. S., *Head Ent.; Actg. State Ent.*
A. T. Peters,[b] D. V. M., *Head Animal Path.*
Albert E. Davisson, A. B., *Prin. School of Agr., Head Agr. Ed.*
Howard R. Smith, B. S., *Head Animal Husb.*
Archibald L. Haecker, B. S. A., *Head Dairy Husb.*
Fredk. J. Alway, Ph. D., *Head Agr. Chem.*
Rollins A. Emerson, B. S., *Hort.*
Rosa Bouton, A. M., *Home Econ.*
Frank J. Phillips, M. S. F., *For.*
Edwin M. Wilcox, Ph. D., *Agr. Bot.*
Leon W. Chase, B. S., *Farm Mech.*
Edward G. Montgomery, A. M., *Expt. Agron.*
Halsey E. Yates, Capt., U. S. A., *Mil. Sci.; Comdt. of Cadets.*
Charles W. Pugsley, B. S., *Instructional Agron. and Farm Management.*
Geo. E. Condra, Ph. D., *Geog., Econ. Geol.*
James H. Gain, M. D. C., *(Assoc.) Animal Path.*
Val Keyser, B. S., *Supt. of Farmers' Insts.*
Annette E. Philbrick,[c] B. S., *(Assoc.) Home Econ.*
Harriet Folger, B. S., *(Assoc.) Home Econ.*
Julia E. Loughridge, A. B., *(Adjunct) Math.; Asst. Prin. School of Agr.*
Lazelle B. Sturdevant, A. M., M. D., *(Asst.) Animal Path.*
Myron H. Swenk, A. M., *(Adjunct) Ent.; Asst. State Ent.*
Vernon V. Westgate, B. S., *(Adjunct) Hort.*
Percy B. Barker, A. B., *(Adjunct) Soils.*
Ellis Rail, B. S. A., *(Adjunct) Animal Husb.*
R. C. Ashby, B. S., *(Adjunct) Animal Husb.*
R. F. Howard, B. S. in Agr., *(Adjunct) Hort.*
R. S. Trumbull, A. M., *(Adjunct) Agr. Chem.*
W. L. French, B. S. Agr., *(Adjunct) Dairying.*
G. Herbert Coons, A. B., *(Adjunct) Agr. Bot.*
K. A. Ulmann, B. S., *Instr. Dairy Husb.*
Flora Bullock, A. M., *Instr. Engl.*
Alva A. Baer, *Instr. Woodwork.*
Mary V. Zimmer, A. B., *Instr. Math., Phys.*
Ella B. Harper, A. B., *Instr. Home Econ.*
Grace G. Denny,[c] A. B., *Instr. Home Econ.*
Claude K. Shedd, A. B., *Instr. Farm. Mach.*
Gladeth Denny, A. B., *Asst. in German and Hist.*
Edna C. Noble, B. L., *Asst. Libr.*
Samuel McKelvie, *Lect. on Swine Judging.*
Erwin Hopt, B. S., *Asst. School of Agr.*
Mrs. Vada C. Vennum, *Asst. Registrar, School of Agr.*

Agricultural Experiment Station of Nebraska, *Lincoln.*

Department of the University of Nebraska, under the control of the Board of Regents.

STATION STAFF.

E. A. Burnett,[d] B. S., *Dir.*
H. R. Smith, B. S., *Animal Husb.*
A. T. Peters,[b] D. V. M., *Animal Path.*
E. M. Wilcox, Ph. D., *Agr. Bot.*
Frederick J. Alway, Ph. D., *Chem.*
A. L. Haecker, B. S. A., *Dairy Husb.*
Lawrence Bruner, B. S., *Ent.*
E. G. Montgomery, A. M., *Expt. Agron.*
F. J. Phillips, M. S. F., *For.*
E. H. Barbour, Ph. D., *Geol.*
Geo. R. Chatburn, A. M., *Highway Engin.*
R. A. Emerson, B. S., *Hort.*
O. V. P. Stout, C. E., *Irrig. and Drainage Engin.*

[a] Includes only instructors in subjects directly relating to agriculture. Many other members of the university faculty give instruction to students pursuing the course leading to the degree of B. S.

[b] Resigned, to take effect January 1, 1910.

[c] On leave.

[d] In full charge of North Platte Substation.

Geo. A. Loveland, B. S., LL. B., *Met.*
C. W. Pugsley, B. S., *Agron. and Farm Management.*
J. H. Gain, M. D. C., *Assoc. Animal Path.*
W. P. Snyder, A. B., M. S., *Supt. North Platte Substa.*
W. W. Burr, B. S., *Asst. in Soils and Crops, North Platte Substa.*
R. S. Trumbull, A. M., *Asst. in Agr. Chem.*
P. B. Barker, A. B., *Asst. in Soil Agron.*
M. H. Swenk, A. M., *Asst. Ent.* (*Asst. State Ent.*).
G. H. Coons, A. B., *Asst. Agr. Bot.*
Miss V. W. Pool, B. S., M. A., *Asst. in Agr. Bot.*
R. F. Howard, B. S. A., *Asst. Hort.*
L. B. Sturdevant, A. M., M. D., *Asst. Animal Path.*
Ellis Rail, B. S. A., *Asst. Animal Husb.*
Theo. A. Kiesselbach, A. B., B. S., *Asst. in Expt. Agron.*
Erwin Hopt, B. S., *Asst. in Crops and Hort., North Platte Substa.*
Louise Allen,[a] *Seed Lab. Aid.*
S. W. Perin, *Farm Supt.*
J. S. Dales, Ph. M., *Financial Sec.*

NEVADA.

College of Agriculture of the University of Nevada, *Reno.*

GOVERNING BOARD.

Regents of University: John Sunderland, jr.* (*Chair.*), *Reno;* Geo. H. Taylor,* (*Sec.*), *Reno;* C. B. Henderson,* *Elko;* A. A. Codd.* *Goldfield;* J. J. Sullivan,* *Virginia City;* Frank Williams,* *Good Springs.*

COURSES OF STUDY.

The regular course requires four years for completion and leads to the degree of B. S. in Agr. Short courses in agriculture, dairying, and domestic science are given during the months of January, February, and March of each year for the benefit of ranchers. Postgraduate courses and a three-year agricultural course in the university high school are provided.

BOARD OF INSTRUCTION.

Joseph E. Stubbs, M. A., D. D., LL. D., *President of the University, Director of the Experiment Station, and in charge of Farmers' Institutes.*

Herbert W. Hill, B. L., Ph. M., *Engl. Lang. and Lit.*
P. B. Kennedy, Ph. D., *Bot., Hort., For.*
Henry Thurtell, B. S., *Mech., Math.*
Gordon H. True, B. S., *Agr.; Animal Husb.*
Robert Lewers, *V. Pres.; Polit. Econ., Commerce.*
Horace P. Boardman, B. S. in C. E., *Civil Engin.* [*Rural*].
Lowe A. McClure, Lieut., U. S. A., *Mil. Sci. and Tactics.*
Samuel B. Doten, B. A., *Ent.*
Peter Frandsen, A. M., *Biol.*
C. A. Jacobson, Ph. D., *Agr. Chem.*
Sanford C. Dinsmore, B. S., (*Asst.*) *Agr. Chem.*
Chas. S. Knight, B. S., (*Asst.*) *Agron.*
Kate Bardenwerper, B. S., (*Asst.*) *Dom. Sci.*
Leon W. Hartman, Ph. D., *Phys.*
A. C. Gough, B. M. E., *Instr. Mech. Engin.*
Katherine Lewers, (*Asst.*) *Free-Hand Draw.*
Maxwell Adams, Ph. D., *Chem.*
Winfred B. Mack, D. V. M., *Bact., Vet. Sci.*
Eliza H. Overman, B. S., *Asst. in Biol.*
Amos A. Heller, A. M., *Asst. in Bot., Hort.*
Jos. D. Layman, B. L., *Libr.*
Alice E. Armstrong, *Asst. Libr.*

Nevada Agricultural Experiment Station, *Reno.*

Department of University of Nevada, under the control of the Board of Regents.

STATION STAFF.

Joseph E. Stubbs, M. A., D. D., LL. D., *Dir.*
P. B. Kennedy, Ph. D., *Bot., Hort. For.*
Peter Frandsen,[a] A. M., *Consulting Zool.*
G. H. True, B. S., *Agr., Animal Husb.*
S. B. Doten, B. A., *Ent.*
S. C. Dinsmore, B. S., *Chem.*
James E. Church, Ph. D., *Cooperative Observer in Climat. and Met.*
W. B. Mack, D. V. M., *Vet Bact.*
C. A. Jacobson, Ph. D., *Chem.*
A. A. Heller, A. M., *Asst. Bot., Hort.*
Theodore W. Clark, *Farm Supt.*
Miles B. Kennedy, B. S., *Asst. Chem.*
Jos. D. Layman, B. L., *Libr.*
Mrs. T. W. Cowgill, M. A., *Asst. Libr.*

[a] In the service of the U. S. Department of Agriculture.

NEW HAMPSHIRE.

New Hampshire College of Agriculture and the Mechanic Arts, *Durham*.

GOVERNING BOARD.

Board of Trustees: Gov. Henry B. Quinby (*ex officio*), *Concord;* W. M. Parker (*Treas.*), *Manchester;* W. D. Gibbs* (*ex officio*), *Durham;* Warren Brown* (*Pres.*), *Hampton Falls;* Lucien Thompson (*Sec.*), *Durham;* John G. Tallant,* *Pembroke;* Walter Drew, *Colebrook;* Richard M. Scammon, *Stratham;* Rosecrans W. Pillsbury, *Londonderry;* Nahum J. Bachelder,* *Andover;* Edward H. Wason,* *Nashua;* George W. Currier, *Nashua;* George H. Bingham, *Manchester;* Richard W. Sulloway, *Franklin*.

COURSES OF STUDY.

There are five four-year courses of study, viz: Agricultural, mechanical engineering, electrical engineering, chemical engineering, and a general course (open to women), all leading to the degree of B. S.; courses of two years, ten weeks and two weeks, each, in agriculture, and a ten weeks' course in dairying.

BOARD OF INSTRUCTION.

William D. Gibbs, D. Sc., *President*.

Chas. H. Pettee, A. M., C. E., *Dean; Math.*
Clarence W. Scott, A. M., *Hist., Polit. Econ.*
Charles L. Parsons, B. S., *Inorg. Chem.*
Frederick W. Taylor, B. S. A., *Agron.*
E. Dwight Sanderson, B. S. A., *Zool., Ent.*
Arthur F. Nesbit, B. S., A. M., *Phys.*
Richard Whoriskey, jr., A. B., *Mod. Lang.*
F. W. Putnam, B. S., *Draw. and Design.*
Charles Brooks, Ph. D., *Bot.*
Charles E. Hewitt, B. S., M. M. E., *Elect. Engin.*
Bethel S. Pickett, M. S., *Hort.*
E. R. Groves, A. B., B. D., *Engl., Philos.*
Forrest E. Cardullo, M. E., *Mech. Engin.*
G. W. Edgerly, Lieut., U. S. A., *Mil. Sci. and Tactics.*
Fred Rasmussen, B. S. A., (*Assoc.*) *Dairying.*
T. R. Arkell, B. S. A., (*Assoc.*) *Animal Husb.*
Charles James, F. I. C., (*Asst.*) *Inorg. Chem.*
A. M. Buck, M. E., (*Asst.*) *Elect. Engin.*
John C. McNutt, B. S. A., (*Asst.*) *Animal Husb.*
C. Floyd Jackson, B. S., M. A., (*Asst.*) *Zool.*
F. C. Moore, A. B., (*Asst.*) *Math.*
Frank R. Brown, B. S., *Instr. Mach. Work.*
David L. Randall, Ph. D., *Instr. Chem.*
Harry E. Ingham, B. S., *Instr. Wood Work.*
Thomas J. Laton, B. S., *Instr. Draw.*
Evan J. David, A. B., *Instr. Rhet. and Literary Criticism.*
Alban Stewart, A. M., *Instr. Bot.*
David Lumsden, *Asst. in Flor.; Foreman of Grounds.*
T. G. Bunting, B. S. A., *Asst. in Veg. Gard.*
Telesphore Taisne, B. A., B. D., *Asst. in Mod. Lang.*
W. L. Slate, jr., B. S. A., *Asst. in Agron.*
Lester A. Pratt, B. S., *Asst. in Chem.*
Charles W. Stone, A. M., *College Farmer.*
Mabel E. Townsend, A. B., *Registrar.*
Mabel Hodgkins, A. B., *Libr.*
Charlotte A. Thompson, *Asst. Libr.*

New Hampshire College Agricultural Experiment Station, *Durham*.

Department of New Hampshire College of Agriculture and the Mechanic Arts, under the control of the Board of Trustees.

STATION STAFF.

E. Dwight Sanderson, B. S. A., *Dir.; Ent.*
F. W. Taylor, B. S. A., *Agr.*
Fred Rasmussen, B. S. A., *Dairyman.*
Charles Brooks, Ph. D., *Bot.*
B. S. Pickett, M. S., *Hort.*
T. R. Arkell, B. S. A., *Animal Husb.*
J. C. McNutt, B. S. A., *Asst. Animal Husb.*
B. E. Curry, M. S., *Assoc. Chem.*
W. C. O'Kane, M. A., *Asst. Ent.*
Alban Stewart, A. M., *Asst. Bot.*
David Lumsden, *Asst. in Flor.*
T. G. Bunting, B. S. A., *Asst. in Veg. Gard.*

NEW JERSEY.

Rutgers Scientific School, the New Jersey College for the Benefit of Agriculture and the Mechanic Arts, *New Brunswick*.

GOVERNING BOARD.

Board of Trustees: Gov. J. F. Fort (*ex officio*), *Trenton;* W. S. Gummere (*Chief Justice of the State*), *Newark;* Edmund Wilson (*Attorney-General*), *Trenton;* W. H. S

COURSES OF STUDY.

There are ten distinct four-year courses of study: Classical (A. B.), Latin scientific (Litt. B.), general science, agriculture, civil engineering, mechanical engineering, electrical engineering, chemistry, biology, and clay working and ceramics (B. S.); a two-year course in clay working and ceramics, and winter courses of twelve weeks each in general agriculture, dairy farming, and fruit growing and market gardening.

BOARD OF INSTRUCTION.

W. H. S. Demarest, A. M., D. D., *President.*

Francis Cuyler Van Dyck, Ph. D., *Dean; Phys., Expt. Mech.*
Edward A. Bowser, C. E., LL. D., *Math. and Engin. Emeritus.*
Rev. Charles E. Hart, D. D., *Ethics, Evidences of Christianity Emeritus.*
Austin Scott, Ph. D., LL. D., *Hist., Polit. Sci.*
Alfred A. Titsworth, C. E., Sc. D., *Graphics, Civil Engin.*
Julius Nelson, Ph. D., *Biol.*
Byron D. Halsted, D. Sc., *Bot., Hort.*
John B. Smith, D. Sc., *Ent.*
Edward B. Voorhees, D. Sc., *Agr.; Supt. of College Farm.*
Robert W. Prentiss, M. S., *Math., Astron.*
Eliot R. Payson, Ph. D., *Hist., Art of Teaching, (Assoc.) German Lang. and Lit.*
Edward L. Stevenson, Ph. D., *Hist.*
Rev. Henry Du Bois Mulford, M. A., D. D., *Engl. Lang. and Lit.*
J. Volney Lewis, B. E., S. B., *Geol., Min.*
Edwin B. Davis, B. L., *Romance Lang.*
Ralph B. Parrott, Capt., U. S. A., *Mil. Sci. and Tactics.*
Irving S. Upson, M. A., *Registrar, Sec. of Faculty.*
Walter R. Newton, Ph. D., *German Lang. and Lit.*
M. T. Scudder, A. M., *Science of Ed.*
George H. Payson, D. D., *Ethics, Evidences of Christianity.*
Ralph G. Wright, Ph. D., *Chem.*
R. C. H. Heck, M. E., *Mech. Engin.*
Cullen W. Parmelee, B. S., *Clay Working and Ceramics.*
Frank F. Thompson, A. M., E. E., *Elect. Engin.*
Richard Morris, M. S., Ph. D., *Math., Graphics.*
William E. Breazeale, M. S., (*Assoc.*) *Math.*
Albert C. de Regt, M. S., (*Assoc.*) *Chem.*
Chas. H. Whitman, Ph. D., (*Assoc.*) *Engl.*
Jacob. G. Lipman, Ph. D., (*Assoc.*) *Agr.*
Edmond W. Billetdoux, A. M., (*Assoc.*) *Romance Lang.*
Ralph O. Smith, Ph. D., (*Assoc.*) *Chem.*
K. C. Davis, Ph. D., (*Assoc.*) *Agr.; Prin. School of Agr.*
Edward L. Barbour, B. O., M. E., *Instr. Rhet., Elocution.*
Fred H. Dodge, B. A., *Instr. Phys. Training; Dir. Gymnasium.*
Frank R. Pratt, B. S., *Instr. Phys.*
Frederick C. Minkler, B. S. A., *Instr. Agr.*
Albert R. Johnson, B. S., *Instr. Math., Graphics.*
W. Bertram Twiss, A. M., *Instr. Engl.*
Erik S. Palmer, Ph. B., *Instr. Math., Graphics.*

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College, under the control of the Board of Trustees.

STATION STAFF.

Edward B. Voorhees, D. Sc., *Dir.*
I. S. Upson, M. A., *Chief Clerk.*
Julius Nelson, Ph. D., *Biol.*
B. D. Halsted, D. Sc., *Bot., Hort.*
E. H. A. Groth, Ph. D., *Plant Physiol.*
Earle J. Owen, M. S., *Asst. Hort.*
J. B. Smith, Sc. D., *Ent.*
J. G. Lipman, Ph. D., *Soil Chem., Bact.*
Percy E. Brown, B. S., *Asst. Chem.*
Irving L. Owen, B. S., *Asst. Chem.*

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

GOVERNING BOARD.

Board of Managers: Gov. J. F. Fort, *Trenton;* W. H. S. Demarest, *New Brunswick;* Edward B. Voorhees, *New Brunswick;* Ephraim T. Gill, *Haddonfield;* David D. Denise (*Pres.*), *Freehold;* James Neilson, *New Brunswick;* C. H. Cook, *Trenton;* Ogden Woodruff, *Elizabeth;* Henry Marelli, *Paterson;* George E. De Camp, *Roseland;* Cyrus B. Crane, *Caldwell;* George Dorer, *East Orange;* Jos. B. Ward, *Lyons Farms;* H. A. Gaede, *Hoboken;* Alex. P. Owen, *Mickleton;* A. E. Haines, *Medford;* Frank E. Bate, *Fishing Creek;* Philip Todd, *Peapack;* Albert Richards, *Dover;* C. C. Basley, *Maywood;* Edwin Radford, *223 Pearsall ave., Jersey City;* James McCarthy, *9 Fulton ave., Jersey City;* Emil Bonnet, *162 Newark ave., Jersey City.*

STATION STAFF.

Edward B. Voorhees, D. Sc., *Dir.*
Irving S. Upson, M. A., *Sec., Treas.*
Charles S. Cathcart, M. S., *Chem.*
Vincent J. Carberry, *Asst. Chem.*
Clarence L. Pfersch, B. S., *Asst. Chem.*
Leon A. Congdon, B. S., *Asst. Chem.*
L. H. Williamson, *Sampler and Asst.*
J. B. Smith, D. Sc., *Ent.*
Maurice A. Blake, B. S., *Hort.*
Arthur J. Farley, B. S., *Asst. Hort., Market Gard.*
F. C. Minkler, B. S. A., *Animal Hush.*
Walter W. Shute, *Farm Foreman.*
D. Manley Jobbins, *Greenhouse Asst. in Hort.*
Geo. B. Thrasher, *Field Asst. in Hort.*

NEW MEXICO.

New Mexico College of Agriculture and Mechanic Arts, *Agricultural College.*

GOVERNING BOARD.

Board of Regents: R. E. McBride (*Pres.*), *Las Cruces;* Hiram Hadley, *Las Cruces;* Vincent B. May (*Sec. and Treas.*), *Las Cruces;* George Arnot, *Albuquerque;* W. A. Sutherland, *Las Cruces.* Advisory Members: Gov. George Curry, *Santa Fe;* J. E. Clark (*Supt Public Instr.*), *Santa Fe.*

COURSES OF STUDY.

There are seven four-year courses of study, viz: Agricultural, mechanical engineering, civil engineering, electrical engineering, household economics, commerce, and a general or scientific course (B. S.); graduate courses, four-year preparatory course; four-year industrial courses in agriculture, mechanics, domestic science, and business; two-year courses in English and English-Spanish stenography.

BOARD OF INSTRUCTION.

W. E. Garrison, Ph. D., *President of the College; Political Economy.*

Luther Foster, M. S. A., *Dean of Agr.*
Clarence T. Hagerty, M. S., *Math., Astron.*
Elmer O. Wooton, B. S., A. M., *Biol., Geol.*
J. D. Tinsley,[a] B. S., *Phys., Soil Phys., Supt. Farmers' Insts. and Cooperative Expts.*
John R. Macarthur, Ph. D., *Engl., Hist.*
R. Fred Hare, M. S., *Chem.*
Fabian Garcia, M. S. A., *Hort.*
J. O. Miller, B. S., *Registrar; Sten., Typew.*
G. E. Lain, M. S., M. A., *Prin. Sten. Dept.*
F. L. Bixby, B. S., *Civil and Irrig. Eng.*
Caroline W. Daniels, A. M., (*Assoc.*) *Engl.; Dean of Women.*
Margaret H. Haggart, B. S., *Household Econ.*
Merritt L. Hoblit, A. B., *Spanish, Lat.*
John H. Vaughan, A. M., (*Assoc.*) *Hist.*
J. H. Squires, Ph. D., (*Assoc.*) *Agron.*
Chas. P. George, Major, U. S. A. (Retired), *Mil. Sci. and Tactics.*
Singleton R. Mitchell, M. S., (*Asst.*) *Chem.*
Frank Stockton, B. S., (*Asst.*) *Phys.*
H. H. Simpson, B. S., (*Asst.*) *Animal Husb.*
W. F. Schaphorst, B. S., (*Asst.*) *Mech. Engin.*
E. L. Werber, Ph. D., (*Asst.*) *Biol.*
J. A. Anderson, *Asst. Registrar.; Instr. Sten., Typew.*
Lucy M. Lewis, A. B., B. L. S., *Libr.; Asst. in Engl.*
Jesse E. Mundell, B. S. A., *Asst. in Hort.*
J. B. Stoneking, M. E., *Asst. in Irrig.*
R. M. Wilcox, B. E., *Asst. in Engl.*
A. P. Bjerregaard, B. S., *Asst. in Chem.*
F. E. Miller, *Dir. of Music.*
G. E. West, *Asst. in Mech. Engin.*

[a] Resigned, to take effect January 1, 1910.

G. P. Stocker, B. S., *Asst. in Math., Civil Engin.*
Josephine Morton, A. B., *Asst. Libr.*
Mrs. C. P. Phelps, *Asst. in Prep. Dept.*
Fannie Ford, B. S., *Asst. in Prep. Dept.*
F. B. Iles, *Farm Foreman.*
L. W. Iles, *Dairyman.*

Agricultural Experiment Station of New Mexico, *Agricultural College.*

Department of New Mexico College of Agriculture and Mechanic Arts, under the control of the Board of Regents.

STATION STAFF.

Luther Foster, M. S. A., *Dir.*
E. O. Wooton, B. S., A. M., *Bot.*
J. D. Tinsley,[a] B. S., *V. Dir.; Soil Phys., Met.*
Fabian Garcia, B. S., M. S. A., *Hort.*
R. F. Hare, M. S., *Chem.*
J. H. Squires, Ph. D., *Agron.*
E. I. Werber, Ph. D., *Asst. Bot.*
S. R. Mitchell, M. S., *First Asst. Chem.*
Frank Stockton, B. S., *Asst. in Soil Phys.*
H. H. Simpson, B. S., *Asst. in Animal Husb.*
J. E. Mundell, B. S. A., *Asst. in Hort.*
A. P. Bjerregaard, B. S., *Second Asst. Chem.*
F. L. Bixby, B. S., *Irrig. Engin.*
J. B. Stoneking, M. E., *Asst. in Irrig.*

NEW YORK.

New York Agricultural Experiment Station, *Geneva.*

GOVERNING BOARD.

Board of Control: Thos. B. Wilson (*Pres.*), *Halls Corners;* W. O'Hanlon (*Sec. and Treas.*), *Geneva;* Gov. Charles E. Hughes, *Albany;* Comr. Raymond A. Pearson, *Albany;* Alfred G. Lewis, *Geneva;* Edgar G. Dusenbury, *Portville;* Irving Rouse, *Rochester;* Lyman P. Haviland, *Camden;* L. L. Morrell, *Kinderhook;* Elihu S. Miller, *Wading River.*

STATION STAFF.

Whitman H. Jordan, D. Sc., LL. D., *Dir.*
Geo. W. Churchill, *Agr.; Supt. Labor.*
William P. Wheeler, *Animal Indus.*
H. A. Harding, M. S., *Bact.*
Martin J. Prucha, M. S., *Assoc. Bact.*
James K. Wilson, B. S., *Asst. Bact.*
Fred C. Stewart, M. S., *Bot.*
George T. French,[b] B. S., *Asst. Bot.*
Stockton M. McMurron, *Asst. Bot.*
J. G. Grossenbacher, A. B., Ph. B., *Assoc. Bot.*
Lucius L. Van Slyke, Ph. D., *Chem.*
A. W. Bosworth, B. S., *Assoc. Chem.*
E. L. Baker, B. S., *Assoc. Chem.*
Morgan P. Sweeney, M. A., *Asst. Chem.*
Arthur W. Clark, B. S., *Asst. Chem.*
Anton R. Rose, B. S., *Asst. Chem.*
Otto McCreary, *Asst. Chem.*
Jas. T. Cusick, B. S., *Asst. Chem.*
George A. Smith, *Dairy Expert.*
Frank H. Hall, B. S., *Editor and Libr.*
Percival J. Parrott, A. M., *Ent.*
Harold E. Hodgkiss, B. S., *Asst. Ent.*
W. J. Schoene,[b] B. Agr., *Asst. Ent.*
Ulysses P. Hedrick, M. S., *Hort.*
Richard Wellington, B. S., *Asst. Hort.*
M. J. Dorsey, B. S., *Asst. Hort.*
W. H. Alderman, B. S. A., *Asst. Hort.*
Orrin M. Taylor, *Foreman in Hort.*
F. A. Sirrine,[c] M. S., *Special Agt.*
F. E. Gladwin, M. A., (*Fredonia*) *in charge Grape Disease Invest.*
Fredk. Z. Hartzell, M. S., (*Fredonia*) *Ent. Invest.*

New York State College of Agriculture at Cornell University, *Ithaca.*

GOVERNING BOARD.

Board of Trustees of the University: *Ex officio*—Jacob Gould Schurman* (*Pres. of Univ.*), *Ithaca;* Governor, Lieutenant-Governor, Speaker of the Assembly, Commissioner of Education, Commissioner of Agriculture, *Albany;* President of State Agricultural Society, *Albany;* Librarian of the Cornell Library, *Ithaca.* Charles E. Cornell, *Ithaca;* Henry B. Lord, *Ithaca;* Andrew D. White, *Ithaca;* Andrew Carnegie, *New York City;* R. H. Treman,* *Ithaca;* Harry L. Taylor, *Buffalo;* Stewart L. Woodford, *18 Wall street, New York City;* Walter C. Kerr, *10 Bridge street, New York City;* Henry R. Ickelheimer, *Box 1854, New York City;* Chas. S. Shepard, *New Haven, N. Y.;* R. B. Williams, *Ithaca;* Mynderse Van Cleef, *Ithaca;* Frank H. Hiscock, *Syracuse;* C. E. Treman, *Ithaca;* Chas. H. Blood, *Ithaca;* Henry W. Sackett, *Tribune Building, New York City;* John H. Barr,

[a] Resigned, to take effect January 1, 1910. [b] On leave. [c] Riverhead, N. Y.

Syracuse; Robert T. Morris, *616 Madison avenue, New York City;* Henry H. Westinghouse, *165 Broadway, New York City;* Geo. C. Boldt, *Waldorf-Astoria, New York City;* William F. Pratt, *Batavia;* Jas. H. Edwards, *42 Broadway, New York City;* J. T. Newman, *Ithaca;* Wm. H. French, *Chicago, Ill.;* Albert H. Sewell, *Walton;* Emerson McMillin, *New York City;* F. C. Stevens, *Attica;* Thos. B. Wilson, *Halls Corners;* A. R. Eastman, *Waterville;* J. N. Carlisle, *Watertown;* Willard Beahan, *43 Lake Shore Building, Chicago, Ill.;* Chas. C. Dickinson, *New York City;* Emmons L. Williams[a] (*Sec.-Treas.*), *Ithaca;* Charles D. Bostwick (*Asst. Sec.-Treas.*), *Ithaca.*

COURSES OF STUDY.

The college offers a four-year course leading to the degree of bachelor of science in agriculture, a four-year course in home economics, and postgraduate courses leading to advanced degrees. The following opportunities are also offered: General agriculture special work; nature-study special course, two years; winter courses of eleven weeks in agriculture, poultry husbandry, horticulture, dairy industry, and home economics; ten weeks' summer preparatory course; reading courses for farmers and farmers' wives; nature-study correspondence work, and a farmers' week.

BOARD OF INSTRUCTION.

Jacob Gould Schurman, A. M., D. Sc., LL. D., *President of the University.*

Liberty H. Bailey,[a] M. S., LL.D., *Dir. College Agr., Dean Faculty.*
Herbert J. Webber, Ph. D., *Expt. Plant Breeding; Actg. Dir.*
Isaac P. Roberts, M. Agr., *Agr. Emeritus.*
John H. Comstock,[a] B. S., *Ent. Gen. Invertebrate Zool.*
Henry H. Wing,[a] M. S. Agr., *Animal Husb.*
John Craig, M. S. Agr., *Hort.*
T. Lyttleton Lyon, Ph. D., *Soil Tech.*
John L. Stone, B. Agr., *Farm Pract.*
James E. Rice, B. S. A., *Poultry Husb.*
Benj. M. Duggar, Ph. D., *Plant Physiol.*
George W. Cavanaugh, B. S., *Agr. Chem.*
George N. Lauman, B. S. A., *Rural Econ.*
Herbert H. Whetzel, A. M., *Plant Path.*
Elmer O. Fippin, B. S. A., *Soil Tech.*
George F. Warren, M. S. A., Ph. D., *Farm Management, Farm Crops.*
William A. Stocking, jr., M. S. A., *Dairy Indus.*
Alexander D. MacGillivray, Ph. D., (*Asst.*) *Ent. and Invertebrate Zool.*
Wm. A. Riley, Ph. D. (*Asst.*) *Ent.*
James G. Needham, Ph. D., (*Asst.*) *Limnology, Gen. Biol.*
Lowell B. Judson, A. B., B. S., (*Asst.*) *Hort.*
Charles S. Wilson, A. B., M. S. A., (*Asst.*) *Pomol.*
Merritt W. Harper, M. S., (*Asst.*) *Animal Husb.*
Bryant Fleming, B. S. A., (*Asst.*) *Rural Art.*
Wm. C. Baker, B. S. A., (*Asst.*) *Draw.*
Chas. H. Tuck, A. B., (*Asst.*) *Ext. Teaching.*
Charles A. Publow, B. A., M. D., (*Asst.*) *Dairy Indus.*
Jas. A. Bizzell, Ph. D., (*Asst.*) *Soil Tech.*
Clarence A. Rogers, M. S. A., (*Asst.*) *Poultry Husb.*
Paul J. White, M. S. A., Ph. D., (*Asst.*) *Farm Crops.*
Glenn W. Herrick, B. S. A., (*Asst.*) *Econ. Ent.*
Howard W. Riley, M. E., (*Asst.*) *Farm Mech.*
Cyrus R. Crosby, A. B., (*Asst.*) *Ent. Invest.*
Harold E. Ross, B. S. A., (*Asst.*) *Dairy Indus.*
Donald Reddick,[b] Ph. D., (*Asst.*) *Plant Path.*
Harry H. Love, Ph. D., (*Asst.*) *Plant Breeding Invest.*
Arthur W. Gilbert, M. S. A., Ph. D., (*Asst.*) *Plant Breeding Invest.*
A. R. Mann, B. S. A., *Sec. College of Agr.*
Chas. F. Clark, M. S. A., Ph. D., *Instr. Plant Breeding Invest.*
Charles C. Hedges, B. A., B. S., *Instr. Agr. Chem.*
Lewis Knudson, B. S. A., *Instr. Plant Physiol.*
George A. Crabb, B. S. A., *Instr. Soil Tech.*
Edward R. Minns, B. S. A., *Instr. Farm Pract.; Asst. Supt. of College Farms.*
Leon D. Batchelor, B. S., *Instr. Hort.*
George W. Tailby, jr., B. S. A., *Instr. Animal Husb.; Stockman.*
E. S. Savage, M. S. A., *Instr. Animal Husb.*
Lewis J. Cross, B. A., *Instr. Agr. Chem.*
E. S. Guthrie, B. S. A., *Instr. Butter Making, Dairy Indus.*
Milton P. Jones, B. S. A., *Instr. Ext. Teaching.*
George E. Burnap, *Instr. Rural Art.*
Kenneth C. Livermore, B. S. A., *Instr. Farm Crops.*
Martin E. Evans, B. S., *Instr. Farm Mech.*
Alice G. McCloskey, B. A., *Lecturer Nature Study.*
Martha Van Rensselaer, A. B., *Supervisor Farmers' Wives' Reading Course; Lect. in Home Econ.*

[a] On leave.
[b] Detailed to State work at Geneva Station during four months in summer.

Mrs. Anna B. Comstock, B. S., *Lect. in Nature Study.*
Wilford M. Wilson,[a] M. D., *Lect. in Met.*
Flora Rose, B. S., M. A., *Lect. in Home Econ.*
John W. Spencer, (*Westfield*) *Agt. in Ext. Work.*
Hugh C. Troy, B. S. A., *Asst. in Dairy Lab.*
Walter W. Hall, *Asst. in Cheese Making.*
W. E. Griffith, *Asst. in Butter Making.*
H. L. Ayres, *Supt. Dairy Manufactures.*
Chas. H. Van Auken, *Asst. in Animal Husb.*
Ada E. Georgia, *Asst. in Nature Study.*
Clara Nixon, *Asst. in Poultry Husb.*
Robert Matheson, M. S. A., *Asst. in Ent.*
Leonard Haseman, A. M., *Asst. in Ent.*
M. M. McCool, B. S. A., *Asst. in Plant Physiol.*
M. F. Barrus, A. B., *Asst. in Plant Path.*
Eugene P. Humbert, M. S. A., *Asst. in Plant Breeding.*
H. J. Conn, Ph. B., B. S., *Asst. in Soil Tech.*
Anna C. Stryke, A. B., *Asst. in Ent.*
George W. Tailby, *Foreman of Farms.*
Charles E. Hunn, *Gard.*
Henry Jackson Moore, *Gard. Hort. Dept.*
Walter G. Krum, *Supt. Poultry Dept.*
Huber Shull, B. S., (*Napanock*) *Asst. in Poultry Husb.*
Walter S. Lyon, *Asst. in Poultry Invest.*
Alex. T. Moir, *Asst. in Poultry Husb.*
Lee B. Cook, B. S. A., *Asst. in Dairy Indus.*
F. S. Harris, B. S., *Asst. in Soil Tech.*
E. W. Leland, B. S. A., *Asst. in Soil Tech.*
J. H. Phillips, *Asst. in Soil Tech.*
Andrew J. Lamoureux, *Libr.*
H. W. Teeter, *Supt. Plant Breeding Gard.*

Cornell University Agricultural Experiment Station, *Ithaca.*

Department of New York State College of Agriculture at Cornell University, under the control of the Board of Trustees of Cornell University.

STATION STAFF.

L. H. Bailey,[b] M. S., LL. D., *Dir.*
H. J. Webber, Ph. D., *Expt. Plant Breeding; Actg. Dir.*
Albert R. Mann, B. S. A., *Sec. to Dir.*
J. H. Comstock, B. S., *Ent.*
H. H. Wing, M. S. Agr., *Animal Husb.*
John Craig, M. S. Agr., *Hort.*
T. L. Lyon, Ph. D., *Soil Invest.*
B. M. Duggar, M. S., Ph. D., *Plant Physiol.*
John L. Stone, B. Agr., *Farm Pract.*
J. E. Rice, B. S. A., *Poultry Husb.*
G. W. Cavanaugh, B. S., *Chem.*
E. O. Fippin, B. S. A., *Soils.*
W. A. Stocking, jr., M. S. A., *Dairy Bact.*
H. H. Whetzel, A. M., *Plant Path.*
G. F. Warren, M. S. A., Ph. D., *Farm Crops.*
L. B. Judson, A. B., B. S., *Hort.*
C. S. Wilson, A. B., M. S. A., *Pomol.*
M. W. Harper, M. S., *Animal Husb.*
G. W. Herrick, B. S. A., *Agr. Ent.*
J. A. Bizzell, Ph. D., *Soil Invest.*
C. A. Publow, B. A., M. D., *Dairy Indus.*
C. R. Crosby, A. B., *Expt. Ent.*
C. A. Rogers, M. S. A., *Poultry Husb.*
P. J. White, M. S. A., Ph. D., *Farm Crops.*
A. W. Gilbert, M. S. A., Ph. D., *Plant Breeding.*
H. H. Love, Ph. D., *Asst. in Plant Breeding.*
Donald Reddick,[c] Ph. D., *Plant Path.*
C. F. Clark, M. S. A., Ph. D., *Agron.*
E. R. Minns, B. S. A., *Farm Pract.*
G. A. Crabb, B. S. A., *Soils.*
E. S. Guthrie, B. S. A., *Butter Making.*
E. S. Savage, M. S. A., *Animal Husb.*
E. P. Humbert, M. S. A., *Asst. in Plant Breeding.*
H. J. Conn, Ph. B., B. S., *Asst. in Soil Invest.*
M. F. Barrus, A. B., *Asst. Plant Path.*
E. W. Leland, B. S. A., *Asst. in Soil Tech.*
J. H. Phillips, *Asst. in Soil Tech.*

NORTH CAROLINA.

The North Carolina College of Agriculture and Mechanic Arts, *West Raleigh.*

GOVERNING BOARD.

COURSES OF STUDY.

There are seven four-year courses of study, viz: Agricultural (B. S.); civil, mechanical, electrical, and mining engineering, and textile science and art (B. E.), and chemistry and

[a] Detailed by Weather Bureau, U. S. Department of Agriculture.
[b] On leave.
[c] Detailed to State work at Geneva Station during four months in summer.

dyeing (B. S.); graduate courses; one and two year normal courses for industrial teachers; short courses of two years in mechanic arts and textile art; one-year course in agriculture; a seven weeks' winter course in general agriculture and dairying; a one-week cotton course; and a May school (one month) for agricultural teachers.

BOARD OF INSTRUCTION.

Daniel Harvey Hill, A. M., Litt. D., *President.*

William A. Withers, A. M., *Chem.*
Frank L. Stevens, Ph. D., *Bot., Veg. Path.*
Clifford L. Newman, M. S., *Agr.*
John Michels, M. S. A., *Animal Husb. and Dairying.*
Guy A. Roberts, B. S., D. V. S., *Vet. Sci.*
Thomas P. Harrison, Ph. D., *Engl.*
Robert E. L. Yates, A. M., *Math.*
John S. E. Young, Lieut., U. S. A., *Mil. Sci. and Tactics.*
Ira O. Schaub, B. S., *Agr. Ext.*
William H. Browne, jr., A. B., *Phys.*
Frank C. Reimer, M. S., *(Assoc.) Hort.*
Ralph I. Smith, B. S., *(Asst.) Ent., Zool.*
George Summey, jr., Ph. D., *(Asst.) Engl.*
Leon F. Williams, Ph. D., *(Asst.) Chem.*
John S. Jeffrey, *Instr. Poultry Husb.*
W. M. Lunn, M. S., *Instr. Agr.*
Hubert Hill, M. S., *Instr. Geol.*
Percy L. Gainey, B. Agr., *Instr. Bot., Bact.*
John G. Hall, A. M., *Instr. Veg. Path.*
John A. Arey, B. S., *Instr. Animal Husb.*
Louis R. Detjen, B. S. A., *Instr. Hort.*
Bascombe B. Higgins, B. S., *Instr. Biol.*
Wayne A. Hornaday, B. S., *Instr. Anat. and Physiol.*
Burton J. Ray, Ph. D., *Instr. Chem.*
Clarence A. Sprague, B. S., *Instr. Phys.*
Abraham Rudy, A. B., Pd. D., *Instr. Mod. Lang.*
R. P. Latane, B. S., *Instr. Phys.*
Wiley T. Clay, B. E., *Instr. Woodworking.*
W. F. Morris, B. E., *Instr. Woodworking.*
L. B. Selby, M. E., *Instr. Draw.*
Michael R. Richardson, M. A., *Instr. Math.*
John W. Harrelson, B. E., *Instr. Math.*
J. Olin Faulkner, B. A., *Instr. Engl.*
Benj. S. Skinner, *Farm Supt.*
Arthur F. Bowen, *Bursar.*
Edwin B. Owen, B. S., *Registrar.*
Henry McK. Tucker, M. D., *Physician.*
Elsie L. Stockard, *Libr.*

North Carolina Agricultural Experiment Station, *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts, under control of Trustees of the College.

STATION STAFF.

Charles B. Williams, M. S., *Dir.; Agron.*
W. A. Withers, A. M., *Chem.*
F. L. Stevens, Ph. D., *Veg. Path.*
J. S. Jeffrey, *Poultryman.*
F. C. Reimer, M. S., *Hort.*
R. S. Curtis, B. S. A., *Animal Husb.*
John Michels, M. S. A., *Dairy Husb.*
R. I. Smith, B. S., *Ent.*
G. A. Roberts, B. S., D. V. S., *Vet.*
J. G. Hall, A. M., *Asst. in Plant Diseases.*
W. C. Etheridge, B. Agr., *Asst. Agron.*
A. R. Russell, *Asst. in Field Expts.*
P. L. Gainey, B. Agr., *Asst. Bact.*
B. J. Ray, Ph. D., *Asst. Chem.*
F. W. Sherwood, B. S., *Asst. Chem.*
L. R. Detjen, B. S. A., *Asst. Hort.*
A. F. Bowen, *Bursar.*

Agricultural Experiment Station of the North Carolina State Department of Agriculture, *Raleigh.*

BOARD OF CONTROL.

State Board of Agriculture:* W. A. Graham (*Comr. of Agr., ex officio Chair.*), *Raleigh;* H. C. Carter, *Fairfield;* K. W. Barnes, *Lucama;* William Dunn, *New Bern;* Ashley Horne, *Clayton;* R. W. Scott, *Melville;* A. T. McCallum, *Red Springs;* J. P. McRae, *Laurinburg;* William Bledsoe, *Gale;* W. J. Shuford, *Hickory;* A. Cannon, *Horse Shoe.*

STATION STAFF.

B. W. Kilgore, M. S., *Dir.; Farm Crops; State Chem.*
Franklin Sherman, jr., B. S. Agr., *Ent.*
W. N. Hutt, B. S. A., *Hort.*
T. B. Parker, *Demonstration Work and Farmers' Insts.*
H. H. Brimley, *Naturalist, Curator.*
W. M. Allen, *Food Chem.*
W. G. Chrisman, *Vet.*
J. M. Pickel, Ph. D., *Asst. Chem.*
W. G. Haywood, B. Litt., *Fert. Chem.*
G. M. MacNider, B. S., *Feed Chem., Microscopist.*
L. L. Brinkley, *Asst. Chem.*
S. O. Perkins, B. S., *Asst. Chem.*
Hampden Hill, B. S., *Asst. Chem.*

*All members of the board connected with management of the station.

S. C. Clapp, *Nursery and Orchard Insp.*
S. B. Shaw, B. S., *Asst. Hort.*
Zeno P. Metcalf, B. S., *Asst. Ent.*
J. A. Conover, *Dairyman.*
J. L. Burgess, B. S., *Agron.*
E. L. Worthen, M. S., *Soil Invest.*
W. E. Hearn,[a] *Soil Survey.*
F. P. Drane, *Soil Survey.*
Mary S. Birdsong, *Sec. to Dir.*
R. W. Scott, jr., *Supt. Edgecombe Branch Sta., Rocky Mount.*
F. T. Meacham, *Supt. Iredell Branch Sta., Statesville.*
J. H. Jefferies, *Supt. Pender Branch Sta., Willard.*
R. W. Collett, *Supt. Transylvania Branch Sta., Blantyre, and Buncombe Branch Sta., Black Mountain.*

The Agricultural and Mechanical College for the Colored Race, *Greensboro.*

GOVERNING BOARD.

COURSES OF STUDY.

The courses of study are: Four-year preparatory, and two four-year collegiate courses—the agricultural leading to the degree of B. Agr. and the mechanical leading to the degree of B. S. A two-year course in agriculture is also given.

BOARD OF INSTRUCTION.

James B. Dudley, A. M., LL. D., *President.*

J. D. Chavis, A. M., D. D., *Asst. in Engl.*
C. E. Stewart, *Asst. in Engl.*
John H. Bluford, B. S., A. M., *Dir. Agr. Dept.*
W. F. Debnam, A. B., *Asst. in Agr.; Farm Mgr.*
Wm. F. Robinson, B. Agr., *Asst. in Agr., Florist.*
Chas. N. McCune, *Dir. Dairy Dept.*
J. Elmer Dellinger, M. D., *College Physician.*
Martin Goins, *Sec., Libr.*

NORTH DAKOTA.

North Dakota Agricultural College, *Agricultural College.*[b]

GOVERNING BOARD.

COURSES OF STUDY.

Nine four-year courses are provided, each leading to the degree of B. S., viz: Agriculture (with choice of agronomy group, animal husbandry group, or teachers' group), civil engineering, mechanical engineering, pharmaceutical chemistry, household economy, education, veterinary science, biology, and general science. There are also three-year courses in farm husbandry and power machinery; a three-year teachers' course in elementary agriculture and nature study; three-year preparatory and one year subpreparatory courses; two-year courses in pharmacy and domestic economy; twelve weeks' winter lecture courses in agriculture and steam engineering and in domestic science.

BOARD OF INSTRUCTION.

J. H. Worst, LL. D., *President of the College and Director of the Experiment Station; Political Economy.*

Edwin F. Ladd, B. S., *Dean Chem., Pharm.; Dir. Labs.*
Clarence B. Waldron, B. S., *Hort., For.*
Henry L. Bolley, M. S., *Dean of Biol. Dept.; Bot., Plant Path.*
E. S. Keene, B. S., *Mech. Engin., Phys.*
J. H. Shepperd, M. S. A., *Dean Agr.; Agr.*
H. W. McArdle, B. S., *Math.*
James Ulio, Major, U. S. A., *Mil. Sci. and Tactics.*

[a] Assigned by the Bureau of Soils, U. S. Department of Agriculture.
[b] Freight and express address, *Fargo.*

Lewis Van Es, M. D., V. S., *Vet. Sci.*
Daniel E. Willard, A. M., *Geol.*
W. J. Trimble, PH. D., *Hist. Social Sci.*
A. E. Minard, A. M., *Engl. and Lit.*
Max Batt, PH. D., *Mod. Lang.*
W. B. Richards, B. S. A., *Animal Husb.*
Wm. B. Bell, PH. D., *Zool., Physiol.*
Arland D. Weeks, B. A., *Ed.*
Jessie A. Hoover, B. S., *Home Econ.*
Theo. D. Beckwith, M. S., *(Asst.) Bact., Plant Path.*
H. F. Bergman, B. S., *(Asst.) Bot.*
Ray C. Doneghue, M. S. A., *(Asst.) Agron.*
H. L. White, M. A., *(Asst.) Chem.*
G. W. Randlett, B. S. A., *(Asst.) Agr.; Supt. Agr. Ext.*
F. C. Householder, A. B., *(Asst.) Math.*
Robert M. Dolve, B. S., *(Asst.) Farm Mech.*
Geo. A. Abbott, PH. D., *(Asst.) Org. Chem.*
Adolph Ziefle, PH. C., B. S., *(Asst.) Pharm.*
Omar O. Churchill, B. S., *(Asst.) Agron.*
Alfred G. Arvold, B. A., *(Asst.) Engl. and Oratory.*
Abbie L. Simmons, PH. B., *(Asst.) Engl.*
C. I. Gunness, B. S., *(Asst.) Expt. Engin.*
William F. Sudro, B. S., *Instr. Pharmacognosy and Pharm. Problems.*
J. W. Ince, A. M., *Instr. Agr. Chem.*
R. E. Remington, B. A., *Instr. Food Chem.*
Oliver W. Dynes, B. S., *Instr. Animal Husb.*
Serene B. Ash, *Instr. Sew.*
Arthur Rueber, B. A., *Dir. Athletics.*
Hugh J. Hughes, B. S., *Instr. Journalism.*
Irwin W. Smith, A. M., *Instr. Math.*
Haile Chisholm, *Instr. Forge Shop.*
Geo. L. Tibert, *Instr. Wood Shop.*
Edith C. Fowler, B. S., *Instr. Home Econ.*
M. B. Erickson, B. S., *Instr. Steam Engin.*
Mrs. Adele Shepperd, *Asst. in Chem. Lab.*
W. L. Stockham, M. S., *Asst. in Chem. Lab.*
Emily E. May, M. S., *Asst. in Chem.*
Mrs. Ethel McVeety, *Libr.*
Alfred H. Parrott, A. M., *Registrar; Prin. Agr. and Manual Training School.*
W. A. Yoder, *Sec.*
Elizabeth Schryver, *Asst. Libr.*

North Dakota Agricultural Experiment Station, *Agricultural College.*

Department of North Dakota Agricultural College, under the control of the Board of Trustees.

STATION STAFF.

J. H. Worst, LL. D., *Dir.*
E. F. Ladd, B. S., *Chem.*
C. B. Waldron, B. S., *Hort., Ent.*
H. L. Bolley, M. S., *Bot., Plant Path.*
J. H. Shepperd, M. S. A., *V. Dir.; Agr.*
W. B. Bell, PH. D., *Asst. Bot. (Plant Survey).*
Lewis Van Es, M. D., V. S., *Vet.*
W. B. Richards, B. S. A., *Asst. Animal Husb.*
O. O. Churchill, B. S., *Asst. in Plant Breeding.*
T. D. Beckwith, M. S., *Asst. Bact. Bot., (Plant Path.).*
R. C. Doneghue, M. S. A., *Asst. Agr. (Soils).*
H. F. Bergman, B. S., *Asst. Bot. (Myc.).*
H. L. White, M. A., *Asst. Chem. (Cereals).*
Adolph Ziefle, PH. C., B. S., *Chem. (Drugs).*
R. E. Remington, B. A., *Chem. (Foods).*
Mrs. Adele Shepperd, *Asst. Chem. (Water and Foods).*
W. F. Sudro, B. S., *Asst. Chem. (Drugs).*
O. W. Dynes, B. S., *Asst. Poultry Husb.*
R. M. Dolve, B. S., *Asst. Agr. Engin.*
J. W. Ince, A. M., *Asst. Agr. Chem (Soils).*
W. L. Stockham, M. S., *Asst. Chem.*
C. V. Kennedy, *Farm Foreman.*
W. A. Yoder, *Sec.*
Lawrence R. Waldron, M. A., *Supt. Substa., Dickinson.*
O. A. Thompson, B. S., *Supt. Substa., Edgeley.*
E. G. Schollander, B. S., *Supt. Substa., Williston.*
E. D. Stewart, B. S., *Supt. Substa., Langdon.*
Wm. R. Proctor, B. S., *Supt. Demonstration Farms.*

OHIO.

The Colleges of Agriculture and Domestic Science and of Veterinary Medicine, Ohio State University, *Columbus.*

GOVERNING BOARD.

Board of Trustees: Frank E. Pomerene (*Chair.*), *Coshocton;* Oscar T. Corson (*V. Chair.*), *Columbus;* Guy W. Mallon, *Cincinnati;* Carl E. Steeb (*Sec.*), *Columbus;* John T. Mack, *Sandusky;* Oscar E. Bradfute, *Cedarville;* W. J. Sears, *Chillicothe;* Julius F. Stone, *Columbus;* L. F. Sater (*Treas.*), *Columbus.*

COURSES OF STUDY.

The university is divided into seven colleges, as follows: Agriculture and domestic science; arts, philosophy, and science; education; engineering; law; pharmacy; and veterinary medicine.

The college of agriculture and domestic science offers nine distinct courses of study: Four-year courses in agriculture, horticulture, forestry, and domestic science; two-year courses in agriculture and horticulture; ten weeks' winter courses in agriculture and dairying: and a four weeks' course for home makers. Degrees are granted in the four-year courses, as follows: B. S. in agriculture, B. S. in horticulture, B. S. in forestry, and B. S. in domestic science.

The college of veterinary medicine offers a three-year course leading to the degree of D. V. M., and to a certificate of veterinary surgeon to those who fail in certain requirements for admission.

BOARD OF INSTRUCTION.

Rev. William Oxley Thompson, A. M., D. D., LL. D., *President of the University.*

Homer C. Price, M. S. A., *Dean; Rural Econ.; Mgr. Univ. Farm.*
Alfred Vivian, PH. G., *Sec.; Agr. Chem.*
William R. Lazenby, M. AGR., *For.*
Wendell Paddock, M. S., *Hort.*
Henry A. Weber, PH. D., *Agr. Chem.*
Matthew B. Hammond, PH. D., *Econ. and Sociol.*
Christopher E. Sherman, C. E., *Civil Engin.*
George W. Knight,[a] PH. D., *Amer. Hist.*
Joseph R. Taylor, M. A., *Engl.*
Lewis A. Rhoades, PH. D., *German.*
Albert M. Bleile, M. D., *Anat., Physiol.*
Benjamin L. Bowen, PH. D., *Romance Lang. and Lit.*
Joseph V. Denney, B. A., *Engl.*
William McPherson, PH. D., *Chem.*
David S. White, D. V. M., *Dean Vet. Med.*
Herbert Osborn,[a] M. S., *Zool., Ent.; Dir. Lake Lab.*
Frank E. Sanborn, B. S., *Dir. Dept. Indus. Arts.*
Joseph N. Bradford, M. E., *Archi.*
John A. Bownocker, D. S., *Inorganic Geol., State Geol.; Curator Museum.*
Oscar Erf, B. S. A., *Dairying.*
Ruth A. Wardall, M. A., *Dom. Sci.; in charge of Dept. Dom. Sci.*
Charles S. Plumb, B. S., *Animal Husb.*
Charles B. Morrey, B. A., M. D., *Bact.*
David R. Major, PH. D., *Psych.*
James E. Hagerty, PH. D., *Econ. Sociol.*
F. R. Marshall, B. S. A., *Animal Husb.*
Francis L. Landacre, B. A., *Zool., Ent.*
Mary R. Laver, (*Assoc.*) *Art.*
Anna K. Flint, B. S., (*Assoc.*) *Dom. Art.*
Edna N. White, (*Assoc.*) *Dom. Sci.*
Charles A. Bruce, B. A., *Romance Lang. and Lit.*
Thomas E. French, M. E., *Engin. Draw.*
Septimus Sisson, B. S., V. S., *Comparative Anat.*
Arthur G. McCall, B. S. A., *Agron.*
V. M. Shoesmith, M. S., (*Assoc.*) *Agron.*
John H. Schaffner, A. M., M. S., (*Assoc.*) *Bot.*
Alfred P. Dachnowski, PH. D., (*Asst.*) *Bot.*
James S. Hine, B. S., (*Assoc.*) *Zool., Ent.*
Oscar V. Brumley, V. S., (*Assoc.*) *Vet. Med.*
John H. McNeil, M. D. V., *Vet.; Surgery and Obstetrics.*
Charles L. Arnold, M. S., (*Assoc.*) *Math.*
George H. McKnight, PH. D., *Engl.*
Edgar S. Ingraham, PH. D., (*Assoc.*) *Romance Lang. and Lit.*
Vernon H. Davis, M. S. A., (*Asst.*) *Hort.*
John F. Lyman, PH. D., (*Assoc.*) *Agr. Chem.*
James McI. Phillips, M. D., (*Assoc.*) *Comparative Path.*
Robt. F. Earhart, PH. D., (*Assoc.*) *Phys.*
Thomas K. Lewis, B. S., (*Asst.*) *Engin. Draw.*
Wm. L. Evans, PH. D., (*Assoc.*) *Chem.*
Berthold A. Eisenlohr,[a] PH. B., (*Assoc.*) *German Lang. and Lit.*
Eugene F. McCampbell, B. S., (*Assoc.*) *Bact.*
George D. Hubbard, PH. D., (*Asst.*) *Geol.*
Robert F. Griggs, M. A., (*Asst.*) *Bot.*
H. C. Ramsower, B. S. A., (*Asst.*) *Agron.*
Frederick B. Hadley, D. V. M., (*Asst.*) *Anat. and Surgery.*
May Thomas, PH. D., (*Asst.*) *German Lang. and Lit.*
Carson S. Duncan, M. A., (*Asst.*) *Engl.*
Robert Meiklejohn, M. E., (*Asst.*) *Engin. Draw.*
Oliver C. Lockhart, M. A., (*Asst.*) *Econ. and Sociol.*
Grace M. Barels, B. A., (*Asst.*) *Math.*
Julia Titsworth, (*Asst.*) *Art.*
Ernest D. Wald, B. S. A., (*Asst.*) *Agron.*
A. B. Graham, *Supt. Agr. Ext.*
Richmond L. Shields, B. S. A., *Asst. in Agr. Ext.*
William M. Barrows, M. S., *Instr. Zool.*
Frederica Detmers, M. S., *Instr. Bot.*
William C. Morse, M. A., *Instr. Geol.*
O. C. Cunningham, *Instr. Dairying.*
Charles P. Crowe, *Instr. Forging.*
John Chisholm, *Farm Supt.*
Maxwell E. Corotis, *Flor.*
David M. Fyffe, *Supt. Live Stock.*
Firman E. Bear, B. S. A., *Instr. Agr. Chem.*
Wm. L. Clevenger, B. S. A., *Instr. Butter Making.*
Henry W. Vaughan, B. S. A., *Instr. Animal Husb.*
George L. Converse, Capt., U. S. A. (Retired), *Mil. Sci. and Tactics.*
Olive B. Jones, B. A., *Libr.*
Alice Littlejohn, M. D., *Dir. of Phys. Ed. for Women.*

[a] On leave.

H. S. Wingert, M. D., *Dir. of Phys. Ed. for Men.*
Clara O. Smith, B. S., *Asst. in Dom. Sci.*
B. W. Hendrix, B. S. A., *Asst. in Agr. Chem.*
William C. Lassetter, B. S., *Asst. in Soil Phys.*
Theo. W. Ditto, B. S. A., *Asst. in Zool. and Ent.*
Anna F. Blohm, B. S., *Asst. in Dom. Sci.*
L. M. Montgomery, B. S., *Asst. in Hort.*
C. R. Titlow, *Asst. in Agr. Ext.*
George Livingston, B. S. A., *Asst. in Agron.*

Ohio Agricultural Experiment Station, *Wooster.*

GOVERNING BOARD.

Board of Control: John Courtright (*Pres.*), *Ashville;* D. L. Sampson (*Sec.*), *Cincinnati;* W. I. Chamberlain (*Treas.*), *Hudson;* G. E. Scott, *Mount Pleasant;* H. L. Goll, *Stryker.*

STATION STAFF.

Chas. E. Thorne, M. S. A., *Dir.*
W. J. Green, *Hort., For.*
Augustine D. Selby, Ph. D., *Bot.*
C. G. Williams, *Agron.*
John W. Ames, M. S., *Chem.*
Harry A. Gossard, M. S., *Ent.*
B. E. Carmichael, B. S., *Animal Husb.*
L. H. Goddard, C. E., *Expt.*
E. B. Forbes, Ph. D., *Nutrition.*
W. H. Kramer, *Bursar.*
Frank H. Ballou (*Newark*), *Asst. Hort., in charge of Insp. and Ext.*
J. H. Gourley, B. S., *Asst. Hort.*
W. H. Goodwin, B. S., *Asst. Ent.*
John S. Houser, B. S., *Asst. Ent.*
T. F. Manns, M. S., *Asst. Plant Path.*
W. F. Pate, B. S., *Asst. Chem.*
Frank A. Welton, B. S., *Asst. Agron.*
M. O. Bugby, B. S., *Asst. Expt.*
Edmund Secrest, B. S., *Asst. For.*
J. J. Crumley, Ph. D., *Asst. For.*
True Houser, *Asst. in Plant Breeding.*
R. C. E. Wallace, B. S., *Asst. in Soils.*
E. W. Gaither, B. S., *Asst. Chem.*
Gail T. Abbott, A. B., *Asst. Agron.*
A. C. Whittier, B. S., *Asst. in Nutrition.*
R. C. Collison, M. S., *Asst. in Nutrition.*
L. T. Bowser, B. S., *Asst. Chem.*
Ralph E. Caldwell, B. S., *Asst. Animal Husb.*
W. A. Lloyd, B. S., *Asst. Expt.*
C. G. Evans, *Asst. Agron.*
W. M. Cook, B. S., *Asst. in Cooperative Expts.*
W. L. Elser, B. S., *Asst. in Cooperative Expts.*
William Holmes, *Farm Foreman.*
C. A. Patton, *Asst. Foreman; Met.*
Edward Mohn, *Supt. Substa., Strongsville.*
Henry M. Wachter, *Supt. Substa., Germantown.*
Lewis Schultz, *Supt. Substa., Carpenter.*

OKLAHOMA.

Oklahoma Agricultural and Mechanical College, *Stillwater.*

GOVERNING BOARD.

Board of Regents: J. P. Conners (*Pres.*), *Canadian;* J. C. Elliott (*V. Pres.*), *Pauls Valley;* Ewers White (*Treas.*), *McLoud;* R. F. Wilson, *Valliant;* G. T. Bryan, *Perry;* Dan Diehl, *Gotebo;* R. W. Lindsey, *Choteau;* T. Rice, *Hitchcock;* A. C. Cobb, *Wagoner;* J. W. Corley, *Howe;* F. Ikard, *Chickasha;* O. A. Brewer, *Helena.*

COURSES OF STUDY.

There are four-year courses of study in science and literature, agriculture, domestic science and art, mechanical, architectural and civil, and electrical engineering (B. S.); a four-year normal course; a two-year course in agriculture and domestic science; a one-year course in agriculture, and a one-year business course; a special ten weeks' winter term in agriculture and dairying; a four weeks' course in cotton grading and a four weeks' dairy course; a six weeks' summer normal institute; a reading course in agriculture; and a farmers' week.

BOARD OF INSTRUCTION.

J. H. Connell, M. S., *President.*

Lowery L. Lewis, M. S., D. V. M., *Zool., Vet. Sci.*
Oscar M. Morris, B. S., *Hort., Bot.*
Sarah W. Landes, *Dom. Econ.*
Llewellyn A. Moorhouse, M. S. A., *Agron.*
Roy C. Potts, B. S., *Dairying.*
W. W. Johnston, A. M., *Engl.*
Boyd A. Wyse, Ph. D., *German, Lat.*
B. C. Pittuck, B. S., *Dean of District Agr. Schools.*
Ira F. Fravel, Lieut., U. S. A., *Comdt. of Cadets.*
W. A. Linklater, B. S. A., *Animal Husb.*
T. M. Jeffords, *School Agr.*
Hardee Chambliss, Ph. D., *Chem.*
Carl Gunderson, Ph. D., *Math.*

C. E. Sanborn, M. A., *Ent.*
Rebecca Acheson, *Dom. Art.*
C. J. Bushnell, Ph. D., *Hist., Polit. Econ.*
John H. Bowers, Ph. D., *Pedag.*
I. Zackheim, Ph. D., *Dir. Music.*
W. E. Schreiber, A. B., *Dir. Phys. Training.*
Henry P. Miller, M. S., D. V. M., *Prin. School of Agr.*
W. L. Burlison, M. S., *(Asst.) Agron.*
W. P. Webber, A. M., *(Asst.) Math.*
L. H. Rose, *(Asst.) Chem.*
Albert Stocker, B. S., *(Asst.) Dairy Husb.*
G. M. Lambert, B. S. A., *Field Dairyman.*
Howard G. Seldomridge, *Instr. Public Speaking, Asst. in Engl.*
Harriett Day, *Instr. Draw. and Art Work.*
T. A. Robinson, *Instr. Cotton Grading.*
E. Carroll Beach, *Instr. Violin.*
Winfred R. Wright, B. S., *Asst. in Bact.*
A. R. Ewing, *Asst. in Math.*
J. A. Ratcliff, B. S., *Asst. in Agron.*
A. L. Lovett, B. S., *Asst. in Ent.*
W. E. Lawrence, B. S., *Asst. in Hort., Bot.*
Madge B. Sanders, *Asst. in Music.*
Martha B. McKinley, B. S., *Asst. in Dom. Sci.*
Pearl Wiar, B. S., *Asst. in Dom. Econ.*
Orpha Caton, B. S., *Asst. in Dom. Sci.*
L. F. Stewart, *Asst. in Engl.*
Ada B. House, *Asst. in Math., Engl.*
Rose Murray, *Asst. in Piano.*
Cora A. Miltimore, A. B., *Libr.*
Hazel McIlvain, *Asst. Libr.*
Emma J. Ross, *Dir. Phys. Training for Women.*
R. E. Anderson, B. S., *Registrar.*
Edwin Gallagher, B. S., *Asst. Phys. Dir.*
W. W. Evans, B. S., *Farm Supt.*
Monroe J. Otey, B. S., *Financial Sec.*

Oklahoma Agricultural Experiment Station, *Stillwater.*

Department of Oklahoma Agricultural and Mechanical College, under the control of the Board of Regents.

STATION STAFF.

John A. Craig, B. S. A., *Dir.*
B. C. Pittuck, B. S., *Asst. Dir.*
L. L. Lewis, M. S., D. V. M., *Vet., Bact.*
O. M. Morris, B. S., *Hort., Bot.*
L. A. Moorhouse, M. S. A., *Agron.*
W. A. Linklater, B. S. A., *Animal Husb*
R. C. Potts, B. S., *Dairyman.*
C. E. Sanborn, M. A., *Ent.*
W. R. Wright, B. S., *Asst. Bact.*
W. L. Burlison, M. S., *Asst. Agron.*
J. A. Ratcliff, B. S., *Asst. Agron.*
R. O. Baird, B. S., *Asst. Chem.*
A. L. Lovett, B. S., *Asst. Ent.*
Charles Crawford, *Asst. Chem.*
W. E. Lawrence, B. S., *Asst. Hort., Bot.*

Agricultural and Normal University, *Langston.*

GOVERNING BOARD.

Board of Regents: James A. Menefe (*Pres.*), *Guthrie*; J. A. Rouce (*Sec.*), *Cooper*; E. D. Cameron (*State Supt. of Public Instr.*), *Guthrie*; D. L. F. Banks, *Enid.*

COURSES OF STUDY.

The courses of study are six: Classical (B. A.); scientific (B. S.); normal (B. S. D.); agricultural (B. S. Agr.); electrical and mechanical engineering (B. M. E.); civil architecture (B. M. E.). Each course requires four years for completion. There is also a three-year college preparatory course and a four-year normal elementary course.

BOARD OF INSTRUCTION.

Inman E. Page, M. A., *President; Psychology and Moral Philosophy.*

H. F. Mitchell, *Math.*
Mary L. McCrary, *Dom. Econ.*
James A. Dingus, *Agr.*
Cora B. Burks, *Dom. Sci.*
Ada Hawes, *Engl.*
W. A. Hinton, *Nat. and Phys. Sci.*
Paralee Lucas, *Asst. in Engl., Arith.*

OREGON.

Oregon State Agricultural College, *Corvallis.*

GOVERNING BOARD.

Board of Regents: J. K. Weatherford (*Pres.*), *Albany*; J. T. Apperson, *Parkplace*; B. F. Irvine (*Treas.*), 724 *Broadway, Portland*; Mrs. Clara H. Waldo, *Macleay*; Gov. F. W. Benson (*Sec. of State, ex officio*), *Salem*; J. H. Ackerman (*State Supt. of Public Instr., ex officio*), *Salem*; Wm. W. Cotton,* *Worcester Building, Portland*; Walter M. Pierce,* *La Grande*; John D. Olwell,* *Central Point*; A. T. Buxton (*Master of State Grange*), *Forest Grove*; E. E. Wilson (*Sec.*), *Corvallis*; C. L. Hawley, *McCoy.*

COURSES OF STUDY.

There are nine four-year courses of study, viz: Agriculture, mechanical engineering, civil engineering, electrical engineering, mining engineering, household economy, commerce, pharmacy, and forestry (B. S.); two-year secondary industrial courses in agriculture, mechanic arts, domestic science and art, commerce, and forestry; a two-year course in pharmacy; a course in industrial pedagogy; a course in music; short winter courses in general agriculture, dairying, horticulture, forestry, mechanic arts, and domestic science and art; a summer school for teachers, a one-week agricultural course for farmers, and a reading course of five lessons in poultry husbandry.

BOARD OF INSTRUCTION.

William J. Kerr, D. Sc., *President.*

James Withycombe, M. Agr., *Animal Husb.; in charge of Farmers' Insts.*
Arthur B. Cordley, M. S., *Dean School of Agr.; Zool., Ent.*
Grant A. Covell, M. E., *Dean School of Engin. and Mech. Arts; Mech. Engin.*
Juliet Greer, A. B., *Dean School of Dom. Sci. and Art; Dom. Sci.*
John A. Bexell, A. M., *Dean School of Commerce; Business Administration; Financial Sec.*
Frederick Berchtold, A. M., *Engl. Lang. and Lit.*
John B. Horner, A. M., Litt. D., *Hist. and Polit. Sci.*
Edward R. Lake, M. S., *Bot. For.*
John Fulton, M. S., *Chem.*
Thomas H. Crawford, A. M., *Coml. Law.*
Claude I. Lewis, M. S. A., *Hort.*
Fred L. Kent, B. Agr., *Dairy Husb.*
Charles L. Johnson, B. S., *Math.*
Emile F. Pernot, M. S., *Bact.*
Gerard Taillandier, *Mod. Lang.*
U. G. McAlexander, Capt., U. S. A., *Mil. Sci. and Tactics; Comdt.*
James Dryden, *Poultry Husb.*
Henry D. Scudder, B. S., *Agron.*
Charles E. Bradley, M. S., *Agr. Chem.*
Emmett D. Angell, *Phys. Ed.*
William A. Jensen, *Recorder of Faculties.*
Edwin DeV. Ressler, M. A., *Indus. Pedag.*
Ida B. Callahan, B. S., (*Asst.*) *Engl. Lang. and Lit.*
Farley D. McLouth, B. S., (*Asst.*) *Art.*
Ida A. Kidder, A. B., B. L. S., *Libr.*
Nicholas Tartar, B. S., (*Asst.*) *Math.*
Charles A. Cole, M. S. A., (*Asst.*) *Pomol.*
Willibald Weniger, Ph. D., (*Asst.*) *Phys.*
Arthur L. Peck, B. S., (*Asst.*) *Landscape Gard.*
John C. Bridwell, B. S., *Instr. Zool., Ent.*
Harry L. Beard, B. S., *Instr. Math.; Dir. of Band.*
Loren B. Baldwin, A. M., *Instr. Engl.*
William M. Porter, *Instr. Forging.*
Elmer P. Jackson, B. S., *Foreman in Carpentry.*
Marion S. Van Liew, *Instr. Dom. Sci.*
Ariel M. Ewing, *Instr. Dom. Art.*
Helen H. Tobin, *Instr. Dom. Art.*
Erwine L. Potter, B. S. A., *Instr. Animal Husb.*
Ralph D. Hetzel, A. B., LL. B., *Instr. Public Speaking and Debating.*
Winifred M. Williams, B. Ph., *Instr. Engl. and Phys. Culture for Women.*
Edward B. Beaty, B. S., *Instr. Math.*
George R. Hyslop, B. S., *Instr. Agron.*
Earle P. Harding, B. S., *Instr. Chem.*
Edna Green, *Instr. Art.*
Myrtle C. Van Deusen, *Instr. Dom. Sci.*
Arthur G. B. Bouquet, B. S., *Instr. Hort.*
Otto G. Simpson, B. S., *Instr. Dairy Husb.*
Fred L. Griffin, B. S., *Instr. Zool., Ent.*
Benton K. Brodie, B. S., *Instr. Chem.*
Rose Z. Angell, *Instr. Home Nursing.*
Edgar R. Shepard, A. M., *Instr. Phys.*
Robert H. Rodgers, B. S., *Instr. Pattern Making.*
Gertrude E. McElfresh, A. B., *Instr. Engl.*
Anna G. Saby, M. A., *Instr. Spanish and Lat.*
E. J. Kraus, B. S., *Instr. Hort.*
Milo R. Daughters, M. S., *Instr. Chem.*
Wilbur L. Powers, M. S., *Instr. Agron.*
Alice L. Edwards, *Asst. in Zool., Ent.*
Helen M. Gilkey, B. S., *Asst. in Bot.*
Glen De Haven, B. S., *Asst. in Bact.*
Frances Huston, *Asst. in Phys. Ed. for Women.*
Alfred Q. Lunn, *Asst. in Poultry Husb.*
James Koeber, B. S., *Asst. in Agron.*
Myrtle E. Knepper, B. S., *Asst. Libr.*

Oregon Experiment Station, *Corvallis.*

Department of Oregon State Agricultural College, under the control of the Board of Regents.

STATION STAFF.

James Withycombe, M. Agr. *Dir.; Animal Husb.*
A. B. Cordley, M. S., *Ent., Plant Path.*
C. E. Bradley, M. S., *Chem.*
E. R. Lake, M. S., *Bot.*
E. F. Pernot, M. S., *Bact.; State Bact.*
C. I. Lewis, M. S. A., *Hort.*
F. L. Kent, B. Agr., *Dairy Husb.*

H. D. Scudder, B. S., *Agron.; Supt. of Farm.*
James Dryden, *Poultry Husb.*
A. L. Peck, B. S., *Flor., Landscape Gard.*
C. A. Cole, M. S. A., *Asst. Hort.*
E. J. Kraus, B. S., *Asst. Hort.*
J. C. Bridwell, B. S., *Asst. Ent.*
F. C. Ewing, B. S., *Asst. Ent.*
A. G. B. Bouquet, B. S., *Oler.*
H. S. Jackson, B. A., *Asst. Plant Path.*
C. C. Vincent,[a] B. S., *Asst. Hort.*
E. L. Potter, B. S. A., *Asst. Animal Husb.*
G. R. Hyslop, B. S., *Asst. Agron.*
R. W. Allen, B. S., *Asst. Hort.; Supt. Umatilla Branch Expt. Sta.*
F. L. Griffin, B. S., *Asst. Ent.*
Alice L. Edwards, *Asst. Ent.*
Glen De Haven, B. S., *Asst. Bact.*
H. V. Tartar, B. S., *Asst. Chem.*
Otto G. Simpson, B. S., *Asst. Dairyman.*
James Koeber, B. S., *Asst. Agron.*
A. Q. Lunn, *Asst. Poultryman.*
Lyman Bundy, B. S., *Asst. Chem.*
Bert Pilkington, B. S., *Asst. Chem.*
W. L. Powers, M. S., *Asst. Agron.*
Robert Withycombe, B. S., *Supt. Eastern Oregon Substa., Union.*
P. H. Spillman, *Hort., Eastern Oregon Substa., Union.*
H. J. Umberger, B. S., *Supt. Eastern Oregon Dry-Farm Substa., Moro.*
A. L. Applewhite, B. S., *Farm Foreman.*

PENNSYLVANIA.

The Pennsylvania State College, *State College.*

GOVERNING BOARD.

Board of Trustees: James A. Beaver[a] (*Pres.*), *Bellefonte;* Edwin E. Sparks[a] (*ex officio, Sec.*), *State College;* Gov. Edwin S. Stuart (*ex officio*), *Harrisburg;* Charles H. Bergner (*ex officio, Pres. of the State Agr. Soc.*), *Harrisburg;* Nathan C. Schaeffer (*ex officio, Supt. of Public Instr.*), *Harrisburg;* N. B. Critchfield (*ex officio, Sec. State Bd. of Agr.*), *Harrisburg;* Charles M. Schwab, *Pittsburg;* John A. Woodward,[a] *Howard;* H. Walton Mitchell (*V. Pres.*), *Pittsburg;* James L. Hamill, *Columbus, Ohio;* John F. Shields, *Philadelphia;* Lloyd B. Huff, *Greensburg;* Geo. M. Downing, *Philadelphia;* Gabriel Hiester,[a] *Harrisburg;* Geo. G. Hutchison, *Warriors Mark;* Augustus C. Read, *Pittsburg;* James G. White, *New York City;* E. S. Bayard,[a] *Pittsburg;* Marlin E. Olmsted, *Harrisburg;* Charles Miller, *Franklin;* Andrew Carnegie, *Pittsburg;* H. V. White,[a] *Bloomsburg;* William F. Hill,[a] *Huntingdon;* Ellis L. Orvis, *Bellefonte;* James E. Quigley, *Pittsburg;* William H. Walker, *Newtonville, Mass.;* Thomas W. Barlow, *Philadelphia;* Milton W. Lowry, *Scranton;* S. O. Frantz, *Rohrerstown;* V. C. McCormick,[a] *Harrisburg;* Wm. H. Patterson, *Clearfield;* Wm. T. Creasy, *Catawissa;* John Hamilton (*Treas.*), *Washington, D. C.*

COURSES OF STUDY.

The courses of study, each requiring four years for completion, unless otherwise specified, are as follows: Classical (B. A.) general science, modern language and literature (B. Litt.), historical and political science, philosophy and education, agricultural, home economics, biology, chemistry, civil engineering, electrical engineering, electro-chemical engineering, industrial chemistry, mathematics, mechanical engineering, physics, mines and metallurgy, and sanitary engineering (B. S.); two-year courses in mechanics and agriculture, respectively; a teachers' course in mechanic arts; short courses in agriculture, dairying, creamery work, horticulture, and poultry husbandry; correspondence courses in agriculture, postgraduate courses, a six weeks' summer session, and a farmers' week.

BOARD OF INSTRUCTION.

Edwin Erle Sparks, PH. D., LL. D., *President; Dean of the School of the Liberal Arts.*

Judson P. Welsh, D. SC., PH. D., LL. D., *Dean of the Colleges.*
William A. Buckhout, D. SC., *Bot.*
William Frear, PH. D., *Expt. Agr. Chem.*
George G. Pond, PH. D., *Chem.; Dir. Chem. Lab.; Dean School of Nat. Sci.*
Henry P. Armsby, PH. D., LL. D., *Dir. Institute of Animal Nutrition.*
Benjamin Gill, M. A., D. D., *Greek, Lat.; Chaplain.*
Thos. F. Hunt, D. AGR., D. SC., *Dean School of Agr.*
Sara C. Lovejoy, B. A., *Dean of Women.*
Erwin W. Runkle, PH. D., *Psych. and Ethics.*
Joseph M. Willard, B. A., *Math.*
Fred L. Pattee, M. A., *Engl. Lang. and Lit.*
Carl D. Fehr, M. A., *German.*
Irving L. Foster, M. A., *Romance Lang.*
William H. Hay, Capt., U. S. A., *Mil. Sci. and Tactics.*
Hubert E. Van Norman, B. S., *Dairy Husb.*
Perley O. Ray, M. A., *Hist. and Polit. Sci.*
Alva Agee, *Agr. Ext.; Prin. of Short Courses; Sec. School of Agr.*
Hugh P. Baker,[a] B. S., M. F., *For.*

[a] On leave.

Ralph L. Watts, B. Agr., M. S., *Hort.*
Frank D. Gardner, B. S., *Agron.*
Thomas I. Mairs, B. Agr., M. S., *Agr. Ed.; Supt. of Corresp. Courses.*
William R. Ham, Ph. D., *Phys.*
Wilbur A. Cochel, B. A., B. S., *Animal Husb.*
Jos. H. Tudor, C. E., M. S., *(Assoc.) Math.*
A. Howry Espenshade, M. A., *(Assoc.) Engl., Rhet.*
H. Freeman Stecker, Ph. D., *(Assoc.) Math.*
Madison M. Garver, B. S., *(Assoc.) Phys.*
Harry R. Fulton, M. A., *(Assoc.) Bot.*
Anna E. Redifer, *(Asst.) Indus. Art and Design.*
Walter J. Keith, Ph. D., *(Asst.) Org. Chem.*
Jesse B. Churchill, B. S., *(Asst.) Indus. Chem.*
J. H. Frizzell, B. A., *(Asst.) Engl., Oratory.*
Elizabeth B. Meek,[a] M. S., *(Asst.) Bact.*
Wilber R. McConnell, B. S., *(Asst.) Zool.*
John P. Stewart, M. S. A., *(Asst.) Expt. Hort.*
Milton S. McDowell, M. S., *(Asst.) Expt. Agr. Chem.*
B. E. Brown,[a] M. S., *(Asst.) Expt. Agron.*
Louise Waugh, B. S., *(Asst.) Home Econ.*
William D. Crockett, M. A., *(Asst.) Rhet., Oratory, Hist.; Sec.*
Chas. F. Shaw, B. S., *(Asst.) Agron.*
Carl W. Larson, B. S. A., *(Asst.) Dairy Husb.*
John A. Ferguson, M. A., M. F. *(Asst.) For.*
Margaret B. MacDonald, Ph. D., *(Asst.) Agr. Chem.*
Julia C. Gray, *Libr.*
Lucretia Van T. Simmons, Ph. B., M. A., *Instr. German.*
Emma A. McFeely, *Instr. Indus. Art.*
Thomas E. Gravatt, B. S., *Instr. Math.*
Mahlon J. Rentschler, M. S., *Instr. Qualitative Anal.*
Frederic A. Hillary, M. A., *Instr. German.*
Geo. K. Pattee, M. A., *Instr. Rhet.*
Frederick W. Beal,[b] Ph. B., M. A., *Instr. Math.*
Geo. A. Whittemore, B. A., *Instr. Math.*
E. V. Gage, M. A., *Instr. Romance Lang.*
V. L. Logo, B. S., *Instr. Quantitative Anal.*
Paul D. Potter, B. A., *Instr. Quantitative Anal.*
Jesse F. Stinard, B. A., *Instr. German and French.*
Lulu B. Smith, Ph. B., *Instr. Gymnastics.*
E. A. Cottrell, B. A., *Instr. Hist. and Econ.*
Fred J. Kaufman, B. S., *Instr. Gen. Chem.*
G. C. Chandlee, Ph. B., *Instr. Gen. Chem.*
J. W. Clark,[b] B. S., *Instr. Poultry Husb.*
William S. Dye, jr., M. A., *Instr. Engl.*
Mary T. Harman, B. A., *Instr. Zool.*
Samuel W. Niederhauser, M. A., *Instr. Math.*
Helen H. Atherton, B. M., *Instr. Music.*
Frederick C. Miller, B. A., *Instr. Phys.*
Elizabeth Bemis, B. S., *Instr. Dom. Sci.*
Paul S. Worth, B. A., *Instr. Math.*
Arthur L. Wright, B. Ph., *Instr. Math.*
B. H. Goldsmith, *Instr. German.*
George F. Zook, M. A., *Instr. Hist.*
Wm. J. Wright, B. S., *Instr. Hort.*
J. Ben Hill, B. A., B. S., *Instr. Bot.*
Wm. D. Clark, B. A., M. F., *Instr. For.*
Homer W. Jackson, *Instr. Poultry Husb.*
Lewis E. Armstrong, Ph. B., *Instr. Math.*
Leslie M. Burrage, B. A., *Instr. French.*
Edmund P. Davis, B. A., *Instr. Math.*
J. Frank Jones, B. A., *Instr. Engl.*
Carl E. Marquardt, B. A., *Instr. German.*
Wheeler P. Davey, B. A., *Instr. Phys.*
L. J. Lassalle, B. S., *Instr. Phys.*
Mervin J. Curl, M. A., *Instr. Engl.*
Guy C. Given, B. S., *Asst. in Chem.*
John W. White, B. S., *Asst. in Chem.*
Charles F. Noll, B. S. A., *Asst. in Expt. Agron.*
W. H. McIntire, M. S., *Asst. in Expt. Agron.*
Warren G. Ross, B. S., *Asst. in Agron.*
J. Plummer Pillsbury, *Asst. in Hort.*
Chas. E. Myers, B. S., *Asst. in Hort.*
John A. Runk, *Asst. in Bot.*
C. L. Goodling, B. S., *Asst. in Dairy Husb.*
P. B. Bennetch, B. S., *Asst. in Dairy Husb.*
Edw. K. Hibshman, B. S., *Field Asst. in Expt. Agron.*
Edward S. Erb, M. S., *Asst. Chem.*
Jerome S. Rogers, B. S., *Asst. Chem.*
James E. Toomer, B. S., *Asst. Chem.*
Elizabeth B. Bower, B. S., *Asst. in Dom. Sci. and Chem.*
Frank P. Knoll, *Asst. in Butter Making.*
S. W. Doty, B. S., *Asst. in Animal Husb.*
Harry C. Baker, *Asst. in Corresp. Courses.*
Harry D. Edmiston, *Lab. Asst.*

The Pennsylvania State College Agricultural Experiment Station, *State College.*

Department of the Pennsylvania State College, under the control of the Board of Trustees.

STATION STAFF.

Thomas F. Hunt, D. Agr., D. Sc., *Dir.*
Wm. A. Buckhout, D. Sc., *Bot.*
William Frear, Ph. D., *V. Dir.; Agr. Chem.*
H. E. Van Norman, B. S., *Dairy Husb.*
Alva Agee, *Agr. Ext.*
H. P. Baker,[b] B. S., M. F., *For.*
R. L. Watts, B. Agr., M. S., *Hort.*
F. D. Gardner, B. S., *Agron.*
T. I. Mairs, B. Agr., M. S., *Agr. Ed.*
W. A. Cochel, B. A., B. S., *Animal Husb.*
J. P. Stewart, M. S. A., *Hort.*
Julia C. Gray, *Libr.*
M. S. McDowell, M. S., *First Asst. Chem.*
B. E. Brown,[a] M. S., *Agron.*

[a] Assigned by the Bureau of Soils, U. S. Department of Agriculture.
[b] On leave.

H. R. Fulton, M. A., *Bot.*
Elizabeth B. Meek,[a] M. S., *Bact.*
C. F. Shaw, B. S., *Asst. Agron.*
C. W. Larson, B. S. A., *Asst. Dairy Husb.*
J. A. Ferguson, M. A., M. F., *For.*
Margaret B. MacDonald, Ph. D., *Asst. Chem.*
W. D. Clark, B. A., M. F., *Asst. For.*
W. J. Wright, B. S., *Asst. Hort.*
H. C. Jackson, *Poultry Husb.*
J. P. Pillsbury, *Asst. Hort.*
J. W. White, B. S., *Asst. Chem.*
G. C. Given, B. S., *Asst. Chem.*
C. L. Goodling, B. S., *Asst. Dairy Husb.*
C. F. Noll, B. S. A., *Asst. in Expt. Agron.*
W. H. McIntire, M. S., *Asst. Agron.*
C. E. Myers, B. S., *Asst. Hort.*
S. W. Doty, B. S., *Asst. Animal Husb.*
E. S. Erb, M. S., *Asst. Chem.*
W. G. Ross, B. S., *Asst. Agron.*
P. B. Bennetch, B. S., *Asst. Dairy Husb.*
J. Ben Hill, A. B., B. S., *Asst. Bot.*
E. K. Hibshman, B. S., *Asst. Chem.*
J. E. Toomer, B. S., *Asst. Chem.*
H. D. Edmiston, *Lab. Asst.*

The Pennsylvania State College Institute of Animal Nutrition, *State College*

Department of the Pennsylvania State College, under the control of the Board of Trustees.

INSTITUTE STAFF.

H. P. Armsby, Ph. D., LL. D., *Dir.*
J. A. Fries, M. S., *Asst. Dir.*
Winfred W. Braman, M. S., *Asst. in Animal Nutrition.*
F. W. Christensen, M. S., *Asst. in Animal Nutrition.*
John W. Calvin, B. S., *Asst. in Animal Nutrition.*
D. C. Cochrane, B. S., *Asst. in Animal Nutrition.*
Roy C. Jones, B. S., *Asst. in Animal Nutrition.*

PORTO RICO.

Porto Rico Agricultural Experiment Station, *Mayaguez.*

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

D. W. May, M. Agr., *Special Agent in Charge; Animal Husb.; in Charge of Farmers' Insts.*
J. W. van Leenhoff, *Coffee Expert.*
W. V. Tower, B. S., *Ent.*
Philip L. Gile, A. B., *Chem.*
C. F. Kinman, B. S., *Hort.*
E. G. Ritzman, *Asst. Animal Husb.*
G. L. Fawcett, *Asst. Plant Path.*
Wm. C. Taylor, B. S., *Asst. Chem.*
Thos. B. McClelland, *Asst. Hort.*
Wm. E. Hess, *Expert Gard.*

RHODE ISLAND.

Rhode Island State College, *Kingston.*

GOVERNING BOARD.

Board of Managers: Chas. D. Kimball (*Pres.*), *Providence;* T. G. Mathewson (*V. Pres.*), *East Greenwich;* W. E. Ranger (*State Comr. of Schools*), *Providence;* Philip A. Money (*State Bd. of Agr.*), *Slocum;* Robert S. Burlingame (*Clerk, Treas.*), *Newport;* Jesse V. Watson, *Wakefield;* Charles Estes, *Warren.*

COURSES OF STUDY.

There are four four-year courses of study, viz: Agricultural, with options in agronomy, horticulture, and animal husbandry; engineering, with options in mechanical, electrical, civil, and chemical engineering; teachers' course in applied science and home economics (B. S.); two-year agricultural, home economics, and engineering courses of high-school grade, and a poultry school extending through six weeks.

BOARD OF INSTRUCTION.

Howard Edwards, M. A., LL. D., *President; Political Economy and Social Science.*

Homer J. Wheeler, Ph. D., *Agr. Chem., Geol.*
E. Josephine Watson, M. A., *Lang.*
Harriet L. Merrow, M. A., *Bot.; Sec.*
George E. Adams, B. S., *Agr.*
Virgil L. Leighton, Ph. D., *Chem.*
John Barlow, A. M., *Zool.*
Leonard P. Dickinson, *Phys.*

[a] On leave.

Marshall H. Tyler, B. S., *Math.*
S. H. Webster, B. S., *Civil Engin.*
Clyde B. Coleman, B. S., *Animal Husb.*
Burt L. Hartwell, Ph. D., *Agr. Chem.*
Helen B. Thompson, M. S., *Home Econ.*
Mabel D. Eldred, B. S., *Instr. Drawing.*
Howland Burdick, B. S., *Instr. Dairying.*
Andrew E. Stene, M. S. A., *Supt. College Ext.*
Wm. S. Spencer, B. D., *Argumentation; Instr. Engl.*
Ernest K. Thomas, *Asst. in Hort.*
E. A. Mallette, *Florist.*
D. J. Lambert, *Instr. Poultry Husb.; in charge of Poultry Dept.*
Francis H. Smith, Ph. B., M. S., *Instr. Chem.*
Geo. R. Cobb, B. S., *Instr. Hort.*
Thomas C. Rodman, *Instr. Woodwork.*
Henry G. Stahl, Lieut., U. S. A., *Mil. Sci. and Tactics.*
Mrs. Marian L. Chamberlain, B. S., *Libr.*

Rhode Island Agricultural Experiment Station, *Kingston*

Department of Rhode Island State College, under the control of the Board of Managers.

STATION STAFF.

H. J. Wheeler, Ph. D., *Dir.; Agron.*
Burt L. Hartwell, Ph. D., *Chem.*
G. E. Adams, B. S., *Hort.*
Philip B. Hadley, Ph. D., *Biol.*
P. H. Wessels, B. S., *Asst. Chem.*
W. F. Kirkpatrick, B. Agr., B. E., *Field Asst. in Biol.*
Roy H. Waite, B. S., *Field Asst. in Biol.*
Miss E. E. Amison, B. S., *Lab. Asst. in Biol.*
S. C. Damon, B. S., *Asst. Agron.*
A. L. Whiting, B. S., *Asst. Agron.*
John Daniel, B. S., *Asst. Agron.*
J. Frank Morgan, M. A., *Asst. Chem.*
Nathaniel Helme, *Met.*
L. F. Whipple, *Asst. Chem.*
F. S. Hammett, A. B., *Asst. Chem.*
F. R. Pember, M. S., *Asst. Plant Physiol.*
E. A. Mallette, *Asst. Hort.*

SOUTH CAROLINA.

Clemson Agricultural College of South Carolina, *Clemson College.*[a]

GOVERNING BOARD.

Board of Trustees: Alan Johnstone (*Pres.*), *Newberry;* R. W. Simpson, *Pendleton;* P. H. E. Sloan (*Sec. and Treas.*), *Clemson College;* M. L. Donaldson, *Greenville;* B. H. Rawl,* *Washington, D. C.;* B. R. Tillman,* *Trenton;* W. W. Bradley, *Abbeville;* W. D. Evans, *Cheraw;* R. I. Manning, *Sumter;* J. E. Wannamaker,* *St. Matthews;* Ivy M. Mauldin, *Pickens;* J. H. Hardin, *Chester;* J. C. Richards, jr., *Liberty Hill,* C. D. Mann, *West Union.*

COURSES OF STUDY.

There are seven four-year courses of study leading to the degree of B. S., viz: In agriculture, agriculture and chemistry, agriculture and animal husbandry, mechanical and electrical engineering, civil engineering, chemistry and geology, and textile industry; two-year courses in agriculture and textile industry, a one-year preparatory course, and a six weeks' cotton grading course. Special courses are given to farmers and others of mature age who desire to avail themselves of the privileges of the college.

BOARD OF INSTRUCTION.

Walter M. Riggs, E. M. E., *Acting President; Director of Mechanical and Electrical Department.*

Mark B. Hardin, *Dir. Chem. Dept.*
David N. Barrow, B. S., M. A., *in charge of Farmers' Insts.*
Charles M. Furman, B. A., *Engl.*
Wm. S. Morrison, B. A., *Hist., Polit. Econ.*
M. B. Stokes, Capt., U. S. A., *Comdt.; Mil. Sci.*
Samuel M. Martin, B. S., *Math.*
Fred H. H. Calhoun, Ph. D., *Geol., Min.; Actg. Dir. Dept. of Agr.*
Hale Houston, C. E., *Civil Engin.*
David W. Daniel, M. A., (*Assoc.*) *Engl.*
Rudolph E. Lee, B. S., (*Assoc.*) *Draw.*
Robert A. Hall, Ph. D., (*Asst.*) *Chem.*
John W. Gantt, (*Asst.*) *Forge and Foundry.*
M. Ray Powers, D. V. S., (*Assoc.*) *Vet. Sci.; State Vet.*
Dennis C. Mooring, M. S., (*Assoc.*) *Hort.*
Frank Bogard, B. M. E., *Instr. Draw.*
Joseph E. Hunter, B. S., (*Asst.*) *Math.*
Thomas W. Keitt, (*Asst.*) *Engl.*
Thomas G. Poats, M. E., E. E., (*Assoc.*) *Phys.*
Chas. S. Doggett, *Dir. Textile Dept.*

[a] Telegraph and express address, *Clemson College;* freight address, Calhoun.

Williston W. Klugh, B. S., (*Asst.*) *Draw.*
R. N. Brackett, PH. D., (*Assoc.*) *Chem.*
Burr H. Johnstone, A. B., (*Asst.*) *Math.*
Andrew Bramlett, B. S., (*Asst.*) *Math.*
Augustus G. Shanklin, B. S., (*Assoc.*) *Math.*
Alexander M. Redfern, B. S., M. D., *Surgeon.*
J. C. Littlejohn, *Instr. Woodwork.*
Andrew B. Gardner, *Asst. in Woodwork.*
T. R. Burruss, jr., B. S., *Instr. Draw.*
Z. R. Lewis, *Asst. in Forge and Foundry.*
D. O. Nourse, B. S., (*Assoc.*) *Animal Husb. and Dairying.*
Lee I. Knight, B. S., (*Assoc.*) *Bot., For.*
Junius M. Burgess, B. S., (*Asst.*) *Animal Husb. and Dairying.*
Arthur B. Bryan, B. S., B. LIT., (*Asst.*) *Engl.*
David H. Henry, B. S., (*Asst.*) *Chem.*
Geo. G. Ainslie, B. S. AGR., (*Asst.*) *Ent.*
Benjamin Freeman, B. S., *Asst. in Chem.*
Mark E. Bradley, B. A., (*Asst.*) *Engl.*
Alester D. Holmes, B. S., (*Asst.*) *Engl., Hist., Geog., Prep. Dept.*
L. A. Sease, B. S., (*Asst.*) *Prep. Dept.*
F. R. Sweeny, B. S., *Instr. Civil Engin.*
Katherine B. Trescot, *Libr.*

South Carolina Agricultural Experiment Station, *Clemson College.*

Department of Clemson Agricultural College, under the control of the Board of Trustees.

STATION STAFF.

J. N. Harper, B. S., M. AGR., *Dir.; Agr.*
H. W. Barre, B. S., *Bot., Plant Path.*
Thos. E. Keitt, B. S., *Chem.*
C. C. Newman, B. S., *Hort.*
A. F. Conradi, M. S., *Zool.; Ent.*
Raymond H. Pond, PH. D., *Plant Path.*
J. N. Hook, *Sec.*
Enoch Barnett, V. M. D., *Animal Husb.; Vet.*
W. D. Garrison, jr., B. S., *Supt. Coast Land Expt. Sta., Summerville; Asst. Agr.*
W. A. Thomas, B. S., *Asst. Zool., Ent.*
G. W. Keitt, B. S., *Asst. Bot., Plant Path.*
Burns Gillison, *Foreman of Sta. Farm.*

The Colored Normal, Industrial, Agricultural, and Mechanical College of South Carolina, *Orangeburg.*

GOVERNING BOARD.

Board of Trustees: Gov. M. F. Ansel (*Chair.*), *Columbia;* W. R. Lowman (*Sec.*), *Orangeburg;* D. J. Bradham, *Manning;* A. L. Dukes, *Orangeburg;* G. B. White, *Chester;* J. W. Floyd, *Kershaw;* C. E. Sawyer, *Aiken.*

COURSES OF STUDY.

The courses of study are four in number and require four years each for completion: The collegiate (B. A.); the agricultural (B. Agr.); the mechanical (B. S.); the normal (L. I., Licentiate of Instruction); and the preparatory, leading up to the four above.

BOARD OF INSTRUCTION.

Thos. E. Miller, LL. D., *President; Agriculturist; Director of Industries; in charge of Farmers' Institutes.*

Robert S. Wilkinson, M. A., PH. D., *Phys., Chem.; Comdt.; Sec.*
H. P. Butler, M. A., *Engl. Lang., Lit., Logic, Lat.*
Nelson C. Nix, M. A., *Math., Mech.*
E. A. Lawrence, *Pedag., Civics,* (*Asst.*) *Agr.*
Ellie N. Levy, *Engl.*
Louise B. Fordham, A. B., *Draw., Art,* (*Adjunct*) *Hist.*
Cecilia H. Holloway, *Instr. Engl., Bookkeeping, Penmanship.*
Ida L. Patrick, *Instr. Reading, Geog.*
Cora Muldrow, *Instr. Physiol., Hyg., Phys. Sci.*
Josie W. Roberts, *Vocal and Instrumental Music.*
James Miller, *Farm Supt.; Instr. Dairying.*
Louisa Blanding, *Instr. Dairying, Cheese Making.*
Miss C. C. Davis, *Dressmaking, Plain Sew.*
Cornelia J. Gregg, *Dom. Econ.; Matron.*
Mattie J. Battiste, *Dom. Econ.*

SOUTH DAKOTA.

South Dakota State College of Agriculture and Mechanic Arts, *Brookings.*

GOVERNING BOARD.

State Board of Regents of Education: E. C. Ericson (*Pres.*), *Elk Point;* A. J. Norby,* *Sisseton;* Albert Anderson, *Sturgis;* A. E. Hitchcock,* *Mitchell;* T. W. Dwight, *Sioux Falls;* I. D. Aldrich (*Sec.*), *Big Stone;* Geo. G. Johnson (*Treas.*), *Pierre.*

COURSES OF STUDY.

Four-year courses, leading to the degree of B. S., are offered in agriculture, home economics, mechanical engineering, electrical engineering, civil engineering, pharmacy, and general science. A fifth-year course in engineering is offered, leading to the degree of M. E., E. E., or C. E. A regular two-year course in pharmacy, leading to the degree of Ph. G., a three-year course in agriculture, a three-year course in home economics, a three-year preparatory course, a three-year course in commercial science, and courses in art and music are also offered. The short industrial courses include two weeks in agriculture, two weeks' dairy course, three months' creamery course, and five months' course in steam engineering.

BOARD OF INSTRUCTION.

Robert L. Slagle, A. M., Ph. D., *President*

James H. Shepard, B. S., *Chem.*
Niels E. Hansen, M. S., *Hort., For.*
Hubert B. Mathews, M. S., *Phys.*
Edward L. Moore, B. S., D. V. S., *Zool., Vet. Med.*
Ada B. Caldwell, *Indus. Art.*
Robert B. Forsee, Pe. P., *Prin. Prep. Dept.*
Albert S. Harding, A. M., *Hist., Polit. Sci.*
James W. Wilson, M. S. A., *Animal Husb.*
Wm. H. Powers, M. A., *Engl.*
William S. Hayes, A. B., *French, German.*
Edith M. Wilcox, B. L., Ed. B., *Home Econ.*
Arthur A. Brigham, Ph. D., *Prin. School of Agr.; Agr. College Ext.*
Edgar W. Olive, Ph. D., *Bot.*
Christian Larsen, M. S. A., *Dairy Husb.*
Madison C. Bates, A. M., *Engl.*
Clifford Willis, M. S., *Agron.*
Joseph N. Rodeheaver, A. M., Ph. D., *Philos., Ed.*
Edward R. Chrisman, Capt., U. S. A., *Mil. Sci. and Tactics.*
J. V. Bopp, B. S., (*Assoc.*) *Agron.*
Harry C. Severin, M. A., *Ent.*
Nola K. Fromme, B. S., *Asst. Prin. School of Agr.*
Maud Goddard, *Instr. Indus. Art.*
Arthur E. Koch, Ph. G., M. S., *Asst. in Chem.*
Gertrude S. Young, A. B., *Instr. Prep. Dept.*
Benj. H. Alton, B. S., *Instr. Zool. and Bact.*
T. Herbert Lund, *Instr. Dairy Husb.*
R. Adams Dutcher, B. S., *Asst. in Chem.*
H. J. Besley, B. A., *Asst. in Agron.*
H. B. Potter, B. S., *Instr. Agron.*
S. Garver, B. S. A., *Asst. in Agron.*
P. H. Moore, *Asst. in Agron.*
W. D. Griggs, B. S., *Asst. in Agron.*
LeRoy F. Miller, B. S., *Dairy Chem.*
Grace Smiley, B. S., *Asst. in Home Econ.*
Amy Kelley, B. S., *Asst. in Home Econ.*
Benjamin L. Thompson, B. S., *Instr. Animal Husb.*
F. C. Stoltenberg, *Flor.*

South Dakota Agricultural Experiment Station, *Brookings*.

Department of South Dakota State College of Agriculture and Mechanic Arts, under the control of the State Board of Regents of Education.

STATION STAFF.

Jas. W. Wilson, M. S. A., *Dir.; Agr., Animal Husb.*
N. E. Hansen, M. S., *V. Dir.; Hort.*
J. H. Shepard, B. S., *Chem.*
E. W. Olive, Ph. D., *Bot.*
E. L. Moore, B. S., D. V. S., *Vet.*
Christian Larsen, M. S. A., *Dairying.*
Clifford Willis, M. S., *Agron.*
T. H. Lund, *Asst. Dairy Husb.*
R. A. Larson, *Sec., Acct.*
F. C. Stoltenberg, *Flor.*
A. E. Koch, Ph. G., M. S., *Asst. Chem.*
R. A. Dutcher, B. S., *Asst. Chem.*
Guy E. Youngburg, Ph. G., *Asst. Chem.*
J. V. Bopp, B. S., *Asst. Agron.* (*Soil Utility*).
H. B. Potter, B. S., *Asst. Agron.* (*Corn*).
H. J. Besley, B. A., *Asst. Chem.*
S. Garver, B. S. A., *Asst. Agron.* (*Corn*).
P. H. Moore, *Asst. Agron.* (*Soil Utility*).
W. D. Griggs, B. S., *Asst. Agron.* (*Cereals*).
Manley Champlin, B. S., *Cooperative Asst.* (*Cereals*).
B. L. Thompson, B. S., *Asst. Animal Husb.*
Orlando White, B. S., *Asst. in Bot.*
LeRoy F. Miller, B. S., *Asst. in Dairy Chem.*

TENNESSEE.

College of Agriculture of the University of Tennessee, *Knoxville*.

GOVERNING BOARD.

Board of Trustees: Brown Ayres* (*Pres.*), *Knoxville;* James Maynard (*Treas.*), *Knoxville;* William Rule (*Sec.*), *Knoxville;* the Governor; Commissioner of Agriculture; Superintendent of Public Instruction; H. G. Kyle, *Rogersville;* E. T. Sanford, *Knoxville;*

Xenophon Wheeler, *Chattanooga;* Harris Brown,* *Gallatin;* Thomas R. Myers, *Shelbyville;* T. F. P. Allison,* *Nashville;* Hu C. Anderson,* *Jackson;* Spencer F. Thomas, *Brownsville;* Rowan A. Greer, *Memphis;* Hu L. McClung, *Knoxville.*

COURSES OF STUDY.

There are ten four-year courses of study, viz: Literary, scientific, home economics (B. A. and B. S.), agricultural science (B. S. A.), civil engineering, mechanical engineering, electrical engineering, mining engineering, chemical, and pharmaceutical (B. S.); two-year courses in agriculture and in pharmacy (Ph. C.); two weeks' courses in agriculture, animal husbandry, dairying, horticulture, poultry husbandry, bee keeping, and domestic science, respectively; and a six weeks' summer course in agriculture for teachers.

BOARD OF INSTRUCTION.

Brown Ayres, Ph. D., LL. D., D. C. L., *President of the University; Physics and Astronomy.*

Cooper D. Schmitt, M. A., *Dean College; Math.*
Chas. E. Wait, C. E., M. E., Ph. D., *Chem.*
H. B. Myers, Capt., U. S. A., *Mil. Sci. and Tactics; Comdt.*
Harcourt A. Morgan,* B. S. A., *Zool., Ent.*
Charles A. Keffer, M. S., *Hort., For.*
Samuel McC. Bain, A. B., *Bot.*
Henry J. Darnall, M. A., *German.*
I. P. Shanks, Ph. D., *(Assoc.) French, Spanish.*
J. T. Brown, jr., M. A., *(Assoc.) Engl.*
Jas. D. Hoskins, A. M., LL. D., *Hist., Econ.*
Charles H. Gordon, Ph. D., *Geol., Min.*
James T. Porter, Ph. D., *(Assoc.) Phys.*
Charles A. Mooers, B. S., *Agron., Agr. Chem.*
John B. Hamilton, M. A., *(Assoc.) Math.*
Catherine A. Mulligan, B. A., *Dean of Women; (Asst.) Home Econ.*
Charles O. Hill, A. B., Ph. C., *(Asst.) Chem., Pharm.*
Gordon M. Bentley, B. S. A., M. A., *(Asst.) Zool., Ent.; State Ent.*
Samuel H. Essary, M. S., *(Asst.) Bot.*
Moses Jacob, V. M. D., *Instr. Vet. Sci.*
John F. Voorhees, *Instr. Met.*
Asa A. Shaeffer, Ph. D., *Instr. Zool.*
Ernest S. Reynolds, Ph. D., *Instr. Bot.*
Chas. H. Lane, B. S. A., M. A., *Instr. Agron.*
Wm. A. Knabe, *Bandmaster.*
Maurice Mulvania, M. S., *Asst. in Bact.*
Edwin C. Cotton, B. S., *Asst. in Ent.*
Louise G. Turner, A. B., *Asst. in Home Econ.*
Sherman Leavitt, M. S., *Asst. in Agr. Chem.*
William K. Hunter, B. S., *Asst. in Chem.*
W. H. Maynard, B. S., *Asst. in Chem.*
E. E. Gary, *Asst. in Chem. Lab.*
Thos. D. Morris, LL. B., *Bursar-Registrar.*
Sabra W. Vought, A. B., B. L. S., *Libr.*
Nelle Nicholas, *Asst. Registrar.*
Lilian B. Scoffin, *Sec. to Pres.*

Tennessee Agricultural Experiment Station, *Knoxville.*

Department of the University of Tennessee, under the control of the Board of Trustees.

STATION STAFF.

H. A. Morgan, B. S. A., *Dir.; Zool., Ent.*
S. McC. Bain, A. B., *Bot.*
C. A. Mooers, B. S., *Chem., Agron.*
C. A. Keffer, M. S., *Hort., For.*
S. E. Barnes,[a] M. S. A., *Field Expert in Dairying.*
Moses Jacob, V. M. D., *Vet.*
S. H. Essary, M. S., *Asst. Bot., Myc.*
G. M. Bentley, B. S. A., M. A., *Asst. Zool., Ent.*
Maurice Mulvania, M. S., *Asst. Bact.*
E. C. Cotton, B. S., *Asst. Ent.*
F. H. Denniss, B. S. A., *Dairyman.*
Sherman Leavitt, M. S., *Soil Chem.*
J. F. Voorhees, *Consulting Met.*
W. K. Hunter, B. S., *Asst. Chem. (Soil Invest.).*
W. H. Maynard, B. S., *Asst. Chem. (Fert. and Feeds).*
W. A. Campbell, *Farm Foreman.*
S. M. Spangler, *Asst. in Plot Work.*
Lake R. Neel, B. S. A., *Asst. in Cooperative Expts., Columbia.*
J. E. Converse, *Asst. in Cooperative Expts., Crossville.*
W. N. Rudd, *Asst. in Cooperative Expts., McMinnville.*
S. A. Robert, *Supt. West Tennessee Expt. Sta., Jackson.*
F. H. Broome, *Libr., Sec.*

[a] In cooperation with the U. S. Department of Agriculture.

TEXAS.

Agricultural and Mechanical College of Texas, *College Station.*

GOVERNING BOARD.

Board of Directors: K. K. Legett (*Pres.*), *Abilene;* T. D. Rowell (*V. Pres.*), *Jefferson;* A. Haidusek, *Lagrange;* J. M. Green, *Yoakum;* Walton Peteet, *Fort Worth;* E. R. Kone, *Austin;* W. P. Sebastian, *Breckenridge;* A. R. McCollum, *Waco.*

COURSES OF STUDY.

The courses of study are as follows: Four-year agricultural, mechanical engineering, textile engineering, electrical engineering, civil engineering, chemical engineering, and architectural engineering (B. S.); special and graduate courses; two-year courses in agriculture and textile engineering; a six weeks' summer school and a six weeks' summer normal school.

BOARD OF INSTRUCTION.

Robert T. Milner, *President.*

Charles Puryear, M. A., C. E., *Dean; Math.*
Mark Francis, D. V. M., *Vet. Sci.*
F. E. Giesecke, M. E., *Draw., Archi. Engin.*
J. C. Nagle, M. A., M. C. E., *Civil Engin.*
O. F. Chastain, *Hist.*
D. W. Spence, B. S., C. E., *Structural Engin.*
Edwin J. Kyle, M. S. A., *Hort.*
Wilmon Newell, M. S., *Ent.*
C. P. Fountain, A. M., *Engl.*
Oscar M. Ball, Ph. D., *Bot., Bact.*
J. B. Bagley, B. S., T. E., *Textile Engin.*
George S. Fraps, Ph. D., (*Assoc.*) *Agr. Chem.; State Chem.*
C. B. Campbell, Ph. B., *Lang.*
J. C. Blake, Ph. D., *Gen. Chem.*
E. J. Fermier, M. E., *Mech. Engin.*
C. H. Alvord, B. S., *Agr., Dairying; Supt. College Farm.*
John C. Burns, B. S., (*Actg.*) *Animal Husb.*
F. C. Bolton, B. S., *Elect. Engin.*
Andrew Moses, *Mil. Sci.; Comdt. of Cadets.*
J. W. Kidd, B. S., C. E., (*Assoc.*) *Phys.*
Robert F. Smith, (*Assoc.*) *Math.*
J. A. Lomax, A. B., (*Assoc.*) *Engl.*
R. H. Leavell, (*Assoc.*) *Hist.*
R. P. Marsteller, D. V. M., (*Asst.*) *Vet. Sci.*
W. P. Nelson, jr., (*Asst.*) *Chem.*
Hiram L. McKnight, (*Asst.*) *Agr.*
J. D. Garner, LL. B., A. M., *Instr. Math.*
James N. Michie, B. A., B. S., *Instr. Math.*
D. C. Jones, A. B., *Instr. Math.*
J. W. Mitchell, A. B., *Instr. Math.*
G. C. Embry, B. L., *Instr. Engl.*
Roy Follette, A. B., *Instr. Engl.*
W. H. Thomas, B. Lit., *Instr. Engl.*
A. Mitchell, B. C. E., *Instr. Draw.*
J. S. Dean, B. S., A. E., *Instr. Draw.*
G. A. Giest, B. S., *Instr. Draw.*
C. L. Wignall, B. S., *Instr. Draw.*
J. L. Thomas, B. S., *Instr. Dairying.*
Helge Ness, M. S., *Instr. Hort.*
S. E. Herrington, B. S., *Instr. Mech. Engin.; Supt. of Shops.*
J. A. Herrington, B. S., *Instr. Mech. Engin.*
W. E. Clark, *Asst. in Shops.*
L. L. Chappelle, *Instr. Forge Work.*
C. K. Standish, *Mach.*
J. E. Lear, B. S., E. E., *Instr. Elect. Engin.*
O. B. Wooten, B. S., *Instr. Phys.*
C. D. Johnson, B. A., *Instr. Phys.*
D. T. Griswold, B. S. A., *Instr. Animal Husb.*
F. H. MacDougal, Ph. D., *Instr. Chem.*
C. S. Tatum, B. S., *Instr. Textile Engin.*
R. J. Potts, B. S., C. E., *Instr. Civil Engin.*
E. Scholl, B. S., *Instr. Ent.*
J. M. Carson, jr., B. S., *Treas.*
A. B. Wilcox, *Sec.*
J. H. Quarles, *Libr.*

Texas Agricultural Experiment Station, *College Station.*

Department of the State Agricultural and Mechanical College of Texas, under the control of the Board of Directors.

STATION STAFF.

H. H. Harrington, *Dir.*
W. C. Welborn, M. P. A., *V. Dir.; Agr.*
J. W. Carson, B. S., *Asst. to Dir., State Feed Insp.*
Mark Francis, D. V. M., *Vet.*
G. S. Fraps, Ph. D., *Chem.; State Chem.*
J. C. Burns, B. S., *Animal Husb.*
Helge Ness, M. S., *Hort.*
Wilmon Newell, M. S., *Ent.*
N. C. Hamner, B. S., *Asst. Chem.*
J. B. Rather, B. S., *Asst. Chem.*
H. L. McKnight, *Asst. Agr.*
R. P. Marsteller, D. V. M., *Asst. Vet.*
E. Scholl, B. S., *Asst. Ent.*
D. T. Griswold, B. S. A., *Asst. Animal Husb.*
A. B. Connor, B. S., *Supt. Cooperative Sta., Chillicothe.*
W. S. Hotchkiss, *Supt. State Sta., Troup.*
E. C. Carlyle, B. S., *Asst. Chem.* (*Feed Control*).
A. C. Deller, *Asst. Chem.* (*Feed Control*).
T. L. Ogier, B. S., *Asst. Chem.* (*Feed Control*).

Prairie View State Normal and Industrial College, *Prairie View.*

GOVERNING BOARD.

Board of Directors: K. K. Legett (*Pres.*), *Abilene;* T. D. Rowell (*V. Pres.*), *Jefferson;* A. Haldusek, *Lagrange;* W. P. Sebastian, *Breckenridge;* Walton Peteet, *Dallas;* A. R. McCollum, *Waco;* E. R. Kone (*ex officio*), *Austin;* R. T. Milner (*ex officio*), *College Station;* John M. Green, *Yoakum.*

COURSES OF STUDY.

A normal industrial course extending through four years and optional along agricultural or mechanical lines is offered. Diplomas are granted. Special courses in mechanic arts, agriculture and horticulture, and dairying are provided.

BOARD OF INSTRUCTION.

E. L. Blackshear, *Principal; Economics and History of Industry.*

J. H. Crawford, *Nat. and Phys. Sci.*
J. T. Hodges, *Pedag., Hist.*
John W. Hoffman, *Agr.*
C. H. Griggs, *Engl.*
N. A. Banks, *Math.*
C. H. Waller, *Asst. in Agr.*
Mrs. T. M. R. Hunt, *Matron.*
Effie E. Houseworth, *Sew., Millinery.*
Paul Bledsoe, (*Assoc.*) *Sci.; Libr.*
R. L. Isaacs, (*Assoc.*) *Math.*
W. C. Rollins, *Bookkeeper, Treas.*
T. T. Thompson, *Sec.*
Martha C. Rodgers, *Dept. of Cooking and Dom. Econ.*
J. H. Morrison, M. D., *Physician.*
A. E. Flewellen, jr., *Blacksm., Elect.*
Miss A. L. Evans, *Asst. in Engl.*
Gussie Adams, *Asst. in Dom. Sci.*
C. L. Foster, *Asst. in Blacksm.*
E. W. Madison, *Tailoring.*
R. F. Johnson, *Shoemaking.*
A. D. Ewell, *Instr. Laundering; Foreman of Laundry Plant.*
Mrs. R. L. Ewell, *Asst. in Laundering.*
Miss M. V. Chestnut, *Asst. in Sew.*
W. B. Woodruff, *Farm Supt.; Instr. Broom and Mattress Making.*
C. Belle Drisdale, *Gen. Asst.*

UTAH.

Agricultural College of Utah, *Logan.*

GOVERNING BOARD.

Board of Trustees: Lorenzo N. Stohl (*Pres.*), *Brigham;* J. L. Coburn (*Financial Sec.*), *Logan;* A. M. Fleming (*Treas.*), *Logan;* Mrs. Susa Y. Gates, *Salt Lake City;* Thomas Smart,* *Logan;* J. Q. Adams, *Logan;* Elizabeth C. McCune (*V. Pres.*), *Salt Lake City;* J. W. N. Whitecotton, *Provo;* J. T. Caine, jr. (*Recording Sec. and Auditor*), *Logan;* Mathonihah Thomas,* *Salt Lake City;* John Dern, *Salt Lake City;* J. C. Sharp, *Salt Lake City.*

COURSES OF STUDY.

There are three-year manual-training courses in agriculture and domestic science, a three-year high school course in commerce, and a four-year manual-training course in mechanic arts, each leading to a certificate of graduation; four-year courses in agronomy, horticulture and entomology, animal husbandry and dairying, irrigation and drainage, forestry, domestic science, commerce, and general science, each leading to the degree of B. S.; a three-year college-preparatory course; also short winter courses in agriculture, domestic science and arts, mechanic arts, commerce, and forestry; a summer school of five weeks; and a farmers' round-up.

BOARD OF INSTRUCTION.

John A. Widtsoe, PH. D., *President.*

Elmer D. Ball, PH. D., *Dir. School of Agr.*
Willard S. Langton, B. S., *Math.*
Joseph W. Jenson, S. B., *Irrig. Engin.; Actg. Dir. School of Mech. Arts.*
James C. Hogenson, M. S. A., *Agron.*
Walter W. McLaughlin,* B. S., *Irrig. and Consulting Drainage.*
Hyrum J. Frederick, D. V. M., *Vet. Sci.*
John T. Caine, III, M. S. A., *Animal Husb.*
George Thomas, A. M., PH. D., *Econ.; Dir. School of Commerce.*
Frank R. Arnold, A. M., *Mod. Lang.*
Lochlin W. Caffey, Lieut., U. S. A., *Mil. Sci. and Tactics.*

* In the service of the U. S. Government.

Robert Stewart, Ph. D., *Chem.*
William Peterson,[a] B. S., *Geol., Phys.*
John T. Caine, jr., B. S., *Registrar, Sec. of Faculty.*
Christian M. Larsen, A. M., *Engl.*
Samuel H. Goodwin, B. D., *Econ. Ornith.*
Lewis A. Merrill, B. S., (*Salt Lake City*) *Dir. Agr. Ext. Work.*
Clayton T. Teetzel, LL. B., *Phys. Ed.*
Edward G. Titus, M. S., *Zool., Ent.*
Franklin L. West, B. S., *Phys.*
Wm. H. Homer, jr., M. S. A., *Hort.*
Ellen A. Huntington, A. M., *Dir. School of Dom. Sci.; Dom. Sci.*
Blanche Cooper, B. S., (*Assoc.*) *Dom. Sci.*
Calvin Fletcher, B. Pd., (*Asst.*) *Art.*
Rhoda B. Cook,[a] (*Asst.*) *Dom. Arts.*
Mary Parmelee, (*Asst.*) *Dom. Arts.*
Elmer G. Peterson,[a] B. S., A. M., (*Asst.*) *Zool., Ent.*
T. E. Woodward, B. S., (*Asst.*) *Dairy Husb.*
Joshua P. Goddard, A. B., C. P. A., (*Asst.*) *Accts.*
Amanda Holmgren, B. S., (*Asst.*) *Engl.*
Jos. E. Greaves, M. S., (*Asst.*) *Agr. Chem.*
Chas. P. Smith, B. S., A. M., (*Asst.*) *Bot.*
N. Alvin Pedersen, A. B., (*Asst.*) *Engl.*
Geo. W. Thatcher, *Music.*
Chas. W. Porter, B. S., A. M., (*Asst.*) *Chem.*
Isaac B. Evans, A. B., (*Asst.*) *Hist.*
Harry C. Parker, B. S., (*Asst.*) *Geol.*
Geo. B. Hendricks, A. M., (*Asst.*) *Econ.*
Louie E. Linnartz, *Instr. Music.*
S. E. Clark, *Instr. Piano, Cornet.*
Roy Rudolph, B. S., *Instr. Math.*
Edward P. Pulley, B. S., *Instr. Mech. Engin.*
Sarah Huntsman, *Instr. Engl.*
Charlotte Kyle, A. M., *Instr. Engl., Hist.*
Jonathan S. Powell, *Instr. Art.*
Hazel Love, B. S., *Instr. Dom. Sci.*
Geo. M. Turpin, B. S., *Instr. Poultry Husb.*
W. L. Walker, B. S., *Instr. Chem., Math.*
Charlotte Stewart, A. B., *Instr. Engl. and Phys. Ed. for Women.*
Ernest P. Hoff, B. S., *Asst. in Ent.*
Edward H. Walters, B. S., *Asst. in Chem.*
Lizzie O. McKay, B. S., *Asst. in Dom. Sci.*
Elizabeth C. Smith, B. L., *Libr.*
Hattie Smith, *Asst. Libr.*
John L. Coburn, B. S., *Financial Sec.; Instr. Math.*
Alma M. Davis, *Instr. Sten., Typew.*
Jean Crookston, *Asst. in Sew.*

Agricultural Experiment Station, *Logan.*

Department of the Agricultural College of Utah, under the control of the Board of Trustees.

STATION STAFF.

E. D. Ball, Ph. D., *Dir.; Ent.*
H. J. Frederick, D. V. M., *Vet.*
John T. Caine, III, M. S. A., *Animal Husb.*
Robert Stewart, Ph. D., *Chem.*
J. C. Hogenson, M. S. A., *Agron.*
S. H. Goodwin, B. D., *Econ. Ornith.*
E. G. Titus, M. S., *Ent.*
L. A. Merrill, B. S. (*Salt Lake City*), *Agron.; in charge of Arid Farms.*
T. E. Woodward, B. S., *Dairyman.*
W. H. Homer, jr., M. S. A., *Actg. Hort.*
J. E. Greaves, M. S., *Assoc. Chem.*
F. D. Farrell, B. S., *Asst. Agron.*
R. A. Hart, B. S., *Asst. Drainage Engin.*
G. M. Turpin, B. S., *Asst. Poultryman.*
W. L. Walker, B. S., *Asst. Chem.*
E. H. Walters, B. S., *Asst. Chem.*
E. P. Hoff, B. S., *Asst. Ent.*
P. V. Cardon, B. S., *Asst. Agron.*

VERMONT.

University of Vermont and State Agricultural College, *Burlington.*

GOVERNING BOARD.

Board of Trustees: M. H. Buckham* (*Pres.*), *Burlington;* Gov. Geo. H. Prouty (*ex officio*), *Newport;* E. C. Mower (*Sec.*), *Burlington;* C. P. Smith (*Treas.*), *211 College street, Burlington;* H. H. Powers, *Morrisville;* J. H. Converse, *Philadelphia, Pa.;* Robert Roberts, *Burlington;* W. S. Webb, *Shelburne;* D. P. Kingsley, *New York City;* B. F. Fifield, *Montpelier;* N. W. Fisk, *Isle La Motte;* Redfield Proctor, *Proctor;* E. J. Ormsbee,* *Brandon;* W. P. Dillingham, *Montpelier;* G. T. Chaffee, *Rutland;* G. S. Fassett,* *Enosburg;* Cassius Peck,* *Burlington;* C. A. Catlin, *Providence, R. I.;* J. G. McCullough, *Bennington;* F. T. Kidder, *Woodstock;* Z. M. Mansur, *Newport;* George Aitkin, *Woodstock.*

COURSES OF STUDY.

The four-year academical courses are eight in number: Classical (B. A.), literary-scientific (Ph. B.), commerce and economics, civil and sanitary engineering, electrical engineering, mechanical engineering, chemical, and agricultural (B. S.), the particular course being specified in the diploma. A two-year course in agriculture, an eight weeks' winter course in agriculture and dairying, a four weeks' summer school for teachers, and a farmers' week are also offered.

[a] On leave.

BOARD OF INSTRUCTION.

Matthew H. Buckham, D. D., LL. D., ***President; Political and Social Philosophy.***

George H. Perkins, Ph. D., *Dean Dept. Arts; Nat. Hist., Geol., Anthropology; State Geol.*
Samuel F. Emerson, Ph. D., *Hist., Sociol.*
Nathan F. Merrill, Ph. D., *Chem.; Dean Dept. Chem.*
Josiah W. Votey, C. E., *Dean Dept. Engin.; Civil Engin.*
Lewis R. Jones,[a] Ph. D., *Bot.*
Joseph L. Hills, Sc. D., *Dean Dept. Agr.; Agron.*
Frederick Tupper, jr., Ph. D., Litt. D., *Engl. Lang. and Lit.*
Allison W. Slocum, M. A., *Phys.*
J. F. Messenger, Ph. D., *Sci. and Art of Teaching.*
Frank A. Rich, V. S., M. D., *Vet. Sci.*
R. M. Washburn, B. Agr., M. S., *Dairy Husb.*
A. R. Gifford, A. M., *Intellectual and Moral Philos.*
Carlton B. Stetson, M. A., *German Lang. and Lit.*
M. B. Cummings, M. S. A., Ph. D., *Hort.*
Chas. W. Mixter, Ph. D., *Polit. Econ.*
E. C. Jacobs, B. S., *Chem. and Min.; Sec.*
A. B. Myrick, Ph. D., *Romance Lang. and Lit.*
Bertha M. Terrill, A. M., *Home Econ.*
Daniel L. Tate, *Mil. Sci. and Tactics.*
James Eaton, *Instr. Mech. Pract.*
Jules Demolins, A. M., *(Asst.) Math.*
Howard A. Edson, B. S., *Instr. Bact.*
Wm. T. Jackman, A. M., *(Asst.) Econ. and Accounting.*
Henry F. Perkins, Ph. D., *(Asst.) Zool.*
Henry B. Shaw, Ph. B., LL. B., *Lect. on Coml. Law.*
Daniel C. Munro, A. B., *Instr. Hyg.; Phys. Dir.*
Max W. Andrews, M. A., *(Asst.) Engl. and Elocution; Registrar.*
Geo. H. Burrows, B. S., *(Asst.) Chem.*
H. E. Cunningham, A. B., *Instr. Sci. German.*
Austin F. Hawes, A. B., M. F., *Lect. in For.*
Chas. A. Kern, B. S., *(Asst.) Chem.*
John P. Helyar, B. S., *Instr. Bot.*
Helen B. Shattuck, A. B., *Libr.*
Cyrus G. Pringle, A. M., Sc. D., *Curator of Herbarium.*

Vermont Agricultural Experiment Station, ***Burlington.***

Department of University of Vermont and State Agricultural College, under the control of the Board of Trustees.

STATION STAFF.

J. L. Hills, Sc. D., *Dir.*
L. R. Jones,[a] Ph. D., *Bot.*
M. B. Cummings, Ph. D., *Hort.*
F. A. Rich, V. S., M. D., *Vet.*
Austin F. Hawes, A. B., M. F., *For.; State For.*
Cassius Peck, *Farm Supt.*
Chas. H. Jones, M. S., *Chem.*
R. M. Washburn, B. Agr., M. S., *Dairy Husb.*
H. A. Edson, B. S., *Bact.*
B. F. Lutman, Ph. D., *Asst. Bot.*
Jos. W. Wellington, B. S., *Asst. Hort.*
P. A. Benedict, B. S., *Asst. Chem.*
Jennie L. Rowell, B. S., *Asst. Chem.*
W. F. Hammond,[b] *Expert in Horse Breeding (Middlebury).*
Stanley Hargreaves, *Gard.*
C. P. Smith, *Treas.*

VIRGINIA.

Virginia Agricultural and Mechanical College and Polytechnic Institute, ***Blacksburg.***

GOVERNING BOARD.

Board of Visitors: J. C. Carrington,* *Charlotte Court House;* C. G. Kizer,* *Norfolk;* J. S. Musgrave, *Pinopolis;* H. M. Smith, jr.,* *Richmond;* P. F. St. Clair,* *Bane;* L. E. Johnson, *Roanoke;* R. J. Noell, *East Radford;* L. D. Kline, *Vaucluse;* J. D. Eggleston (*Supt. of Publ. Instr., ex officio*), *Richmond;* J. M. Barker (*Pres. State Bd. of Agr. and Immigration, ex officio*), *Axton;* C. I. Wade (*Sec.*), *Christiansburg.*

COURSES OF STUDY.

The courses of study are as follows: Four-year agricultural, horticultural, applied chemistry, preparatory veterinary medicine, applied geology, metallurgy and metallography, civil engineering, mechanical engineering, electrical engineering, and mining engineering (B. S.); one-year course in practical agriculture and mechanics (certificate), and a farmers' winter course.

---

[a] Resigned, to take effect February 1, 1910.
[b] In cooperation with the U. S. Department of Agriculture.

BOARD OF INSTRUCTION.

Paul B. Barringer,[a] M. D., LL. D., *President of the College.*

John M. McBryde, Ph. D., Sc. D., LL. D., *Pres. Emeritus.*
Ellison A. Smyth, jr., A. M., LL. D., *Biol., Zool.*
Theo. P. Campbell, A. M., *Mod. Lang.*
Robert J. Davidson, A. M., *Agr. Chem.; Dean of Sci. Dept.*
Richard H. Hudnall, M. A., Ph. D., *Engl.*
Charles E. Vawter, B. S., *Phys.*
J. R. Parrott, *Mech. Arts; Dir. of Shops.*
George W. Walker, A. M., *Lat.*
Francis D. Wilson, Ph. D., *Inorg. Chem.*
John E. Williams, Ph. D., *Math.*
Harvey L. Price, M. S., *Hort.; Dean of Agr. Dept.*
Robert A. Marr, C. E., *Dean of Engin. Dept.; Agr. Engin.*
Wm. R. Dashiell, Capt., U. S. A., *Mil. Sci. and Tactics; Comdt. of Cadets.*
William E. Barlow, Ph. D., *Dean of Graduate Dept.*
William H. Rasche, *Graphics.*
Carol M. Newman, Ph. D., *Rhet.*
James B. McBryde, A. B., C. E., *Org. Chem.*
S. W. Fletcher, Ph. D., *Expt. Agr.*
Lyman Carrier, B. S., *Agron.*
Roy J. Holden, M. S., *Geol. and Min.*
Howard S. Reed, Ph. D., *Myc., Bact.*
Walton K. Brainerd, B. S., *Dairy Husb.*
Wm. D. Saunders, *Dir. of Creamery.*
Nelson D. Mayo, M. S., D. V. S., *Animal Husb. Vet. Sci.*
Alfred W. Drinkard, M. S., *(Assoc.) Hist. and Econ.*
Harry E. Allen, B. S. A., *(Assoc.) Animal Husb.*
Charles W. Holdaway, *Instr. Dairy Husb.; Supt. of Creamery.*
Thomas B. Hutcheson, M. S., *Instr. Agron.*
H. S. Stahl, B. S., *Instr. Bot.*
E. B. Fred,[a] M. S., *Instr. Myc.*
Charles I. Wade, *Treas.*
Mary G. Lacy, *Libr.*
Wm. F. Henderson, M. D., *Surgeon.*

Virginia Agricultural Experiment Station, *Blacksburg.*

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute, under the control of the Executive Committee of the Board of Visitors.

STATION STAFF.

S. W. Fletcher, Ph. D., *Dir.*
H. L. Price, M. S., *Hort.*
W. B. Ellett, Ph. D., *Chem.*
Lyman Carrier, B. S., *Agron.*
W. K. Brainerd, B. S., *Dairyman.*
H. S. Reed, Ph. D., *Plant Path.*
N. S. Mayo, M. S., D. V. S., *Animal Husb.*
T. B. Hutcheson, M. S., *Supt. Plat Expts.*
W. A. P. Moncure, M. S., *Hort. By-product Invest.*
H. H. Hill, B. S., *Asst. Chem.*
E. B. Fred,[a] M. S., *Asst. Bact.*
C. W. Holdaway, *Asst. Dairyman.*
A. W. Drinkard, jr., M. S., *Asst. Hort.*
B. G. Anderson, B. S. (*Appomattox*), *Supt. Tobacco Expts.*
W. L. Mallory, B. S., *Asst. Animal Husb.*
H. E. Allen, B. S. A., *Asst. Animal Husb.*
C. I. Wade, *Treas.*

Virginia Truck Experiment Station, *Norfolk.*

Cooperating with the Virginia Agricultural Experiment Station and the United States Department of Agriculture.

GOVERNING BOARD.

P. B. Barringer (*Pres., ex officio*), *Blacksburg;* W. B. Carney, *Churchland;* J. C. Carrington, (*ex officio*), *Charlotte Court House;* J. M. Barker (*Pres. State Bd. of Agr. and Immigration, ex officio*), *Axton;* John T. Griffin, *Portsmouth;* N. W. Nock, *Onancock.*

STATION STAFF.

T. C. Johnson, B. S. Agr., A. M., *Dir.; Hort.*
Chas. S. Heller, B. S., *Asst. Hort.*
Eugene G. Smyth, *Asst. Ent.*
Geo. R. Parrish, *Treas.*

COOPERATING STAFF.

L. C. Corbett, M. S., *Hort., U. S. Dept. of Agr.*
W. A. Orton, M. S., *Path., U. S. Dept. of Agr.*
F. H. Chittenden, D. Sc., *Ent., U. S. Dept. of Agr.*

[a] On leave.

Hampton Normal and Agricultural Institute, ***Hampton.***

GOVERNING BOARD.

COURSES OF STUDY.

The academic course of study requires four years for completion, and a diploma is given on graduation. There are also trade and agricultural courses for undergraduates, requiring three years. The postgraduate courses are agriculture, three years; trades, three years; normal, domestic science and art, two years; and business, one year.

BOARD OF INSTRUCTION.

Hollis B. Frissell, D. D., LL. D., *Principal; Mental Philosophy.*

Herbert B. Turner, D. D., *Chaplain; Bible Lessons.*
Charles K. Graham, *Dir. Agr. Dept.*
Albert Howe, *Supt. of Grounds and Buildings.*
Wm. H. Scoville, *Sec.*
Martha M. Waldron, M. D., *Resident Physician; Physiol. and Hyg.*
Elizabeth Hyde, *Lady Prin.*
Frank K. Rogers, *Treas.*
Harry J. De Yarmett, *Dir. Armstrong and Slater Memorial Trade School.*
Geo. P. Phenix, *in charge of Normal and Academic Dept.; V. Prin.*
Robt. R. Moton, *Comdt. of Cadets.*
Wm. A. Aery, *Hist.; Editor Southern Workman.*
Rose Alden, *Engl. Lit., Current Events, Geog., Arith.*
Mary J. Arthur, *Cooking.*
Lynn F. Ayer, *Instr. Animal Husb.*
Susan A. Berry, *Asst. in Dairy, Shellbanks Farm.*
Maria W. Bishop, *Engl., Rhet., Geog., Arith.*
George W. Blount, *Bookkeeping.*
Mary A. Bradley, *Matron; Sew.*
Mary B. Briggs, *Bible Hist., Engl. Lit.*
Ada Catlin, *Matron.*
Sarah A. Clements, *in charge of Diet Kitchen; Matron.*
Jessie Coope, *Gymnastics.*
Bessie H. Cooper, *Sew.*
George J. Davis, *Asst. Mgr. Home Farm.*
Jennie E. Davis,* *in charge of Nature Study Bureau and Publications.*
Bessie L. Drew, *Instr. Vocal Music.*
Clara E. Emerson, *Engl., Bible Hist., Reading.*
J. E. England, *in charge of Laundry.*
Marie E. Fisk, *Dom. Sci.*
Margaret Fletcher, *El. Branches, Shellbanks Farm.*
Mary T. Galpin, *in charge of Abby May Home.*
Fannie Gibson, *Instr. Sew., Cooking.*
Annie M. Goodrich, *Engl., Bible, Hist.*
Ethel Gowans, *Instr. Agr.*
Henrietta L. Graves, *Phys., El. Sci.*
Jennie H. Hart, *Sew.*
Mrs. E. O. Hawkes, *Phonics, Engl., Arith., Geog.*
Harriett S. Hayward, *Asst. to V. Prin.*
Leonora E. Herron, *Libr.*
Sherman P. Hollister, *Hort.*
Mary E. Houston, *Current Events, Engl. Lit., Geog., Arith.*
Ethelyn L. Hull, *Math., Engl., Reading.*
Charles S. Isham, *Phys.*
Mrs. Lucy M. B. Jameson, *Matron.*
Emma Johnston, *Math.*
Catherine B. Jones, *Phonics, Engl., Physiol., Reading.*
Margaret V. Jones, *Engl., Geog., Reading.*
Thomas J. Jones, *in charge of Hist., Econ., Civics.*
Walter J. Jones, *Agr. Farm Engin.*
H. B. Jordan, *Asst. Mgr. of Shellbanks Farm.*
Louise Kingsbury, *Dom. Sci.*
Sarah Lane, *Phonics, El. Sci., Physiol., Arith., Engl., Reading.*
Mary Lang, *Asst. in Laundry.*
Anna S. Low, *Engl., Phonics, Physiol., Arith.*
Flora F. Low, *in charge of Math.*
Helen W. Ludlow, *Editor Southern Workman.*
Mary McLean, *Instr. Night School.*
Helen McPherson, *Current Events, Engl., Geog.*

* On leave.

Leigh R. Miner, *Draw.*
Grace L. Morrison, *Math., Engl., Geog., Bible.*
Mary W. Nettleton, *Bible, Geog., Engl., Physiol.*
Caroline D. Pratt, *in charge of Dom. Art Dept.*
Alice M. Price, *El. Sci., Physiol.*
Eliza Quick, *Dom. Sci.*
Adaline B. Rockwell, *Asst. Libr.*
Mrs. Lucy M. Sisson, *Matron at Shellbanks Farm.*
James T. Smith, *Florist.*
Clara M. Snow, *in charge of Shellbanks Farm School.*
Arthur E. Spear, *Instr. Poultry.*
Mrs. J. A. Stevens, *Matron.*
Harriet S. Stone, *Instr. Vocal Music.*
Gertrude Sugden, *Asst. Libr.*
E. Jeannette Taylor, *Matron.*
Wm. O. Tessman, *Instr. Band Music.*
Ida A. Tourtellot, *Draw., Engl., Math., Geog.*
Helen L. Townsend, *Matron in charge of Winona Lodge.*
Jessie A. Townsend, *Matron.*
Margaret W. Twitchell, *Matron.*
Marie Ulsamer, *Math.*
John Urquhart, *Animal Indus.*
Hilda E. Vaughan, *Phonics, Arith., Engl., Geog.*
Capt. Allen Washington, *Asst. Comdt. of Cadets.*
Barton White, *Instr. Gard.*
Sarah White, *Sew.*
Emily H. Williams, *Engl., Arith., Geog., Reading.*

WASHINGTON.

The State College of Washington, *Pullman.*

GOVERNING BOARD.

Board of Regents: Gov. M. E. Hay* (*ex officio*), *Olympia;* Lee A. Johnson* (*Pres.*), *Sunnyside;* J. J. Browne* (*V. Pres.*), *Spokane;* J. S. Anderson,* *Sunnyside;* Peter McGregor,* *Spokane;* Frank J. Barnard* (*Treas.*), *429 Walker Building, Seattle;* E. A. Bryan* (*Sec., ex officio*), *Pullman.*

COURSES OF STUDY.

Four-year courses of study are offered in the following lines: Mathematics and civil engineering, mathematics and physics, domestic economy, pharmacy, mining engineering, chemistry, botany, zoology, agronomy, animal husbandry and dairying, horticulture, veterinary science, economic science and history, electrical engineering, hydro-electrical engineering, and mechanical engineering (B. S.); English language and literature, geology, modern languages, Latin, education, and architecture (B. A.); three-year courses are offered in veterinary science (D. V. S.), in music (B. Mus.), and in elementary science; two-year courses in pharmacy (Ph. G.), forestry, art, bookkeeping, and stenography; a one-year course in artisan work; short courses in agriculture, dairying, and assaying, and a six weeks' summer science school for teachers.

BOARD OF INSTRUCTION.

Enoch A. Bryan, A. M., LL. D., *President.*

Osmar L. Waller, Ph. M., *Math., Civil and Irrig. Engin.*
Elton Fulmer, M. A., *Chem.; State Chem.*
Sofus B. Nelson, D. V. M., *Vet. Sci.; State Vet.*
Charles A. Barry, M. A., *Mod. Lang.*
Albert E. Egge, Ph. D., *Engl. Lit.*
Walter G. Beach, A. M., *Econ. Sci. and Hist.*
R. Kent Beattie, B. S., M. A., *Bot.*
Walter S. Thornber, M. S., *Hort.*
Gertrude McKay, B. S., *Dom. Econ.*
Solon Shedd, M. S., *Geol.*
George Severance, B. S., *Agron.; Actg. Head Dept. of Agr.*
Axel L. Melander, M. S., *Ent.*
Harry E. Mitchell, Capt., U. S. A., *Mil. Sci. and Tactics.*
Charles E. Stangeland, Ph. D., *Polit. Econ.*
Wm. T. Shaw, B. Agr., M. S., *Zool.; Curator of Museum.*
Wyatt E. Ralston, D. V. M., *Physiol. and Bact.*
Charles Timblin, M. A., *Math.*
Chas. A. Isaacs, M. A., (*Assoc.*) *Math., Civil Engin.*
Roscoe W. Thatcher, B. S., M. A., (*Assoc.*) *Chem.*
W. T. McDonald, M. S. A., *Animal Husb.*
Earl E. Wegner, D. V. S., (*Asst.*) *Anat. and Surgery.*
Allison E. Gaw, Ph. D., (*Asst.*) *Engl.*
H. B. Humphrey, Ph. D., (*Asst.*) *Bot.*
Frank A. Chalfant, A. M., (*Asst.*) *German.*
Samuel Morris, M. A., (*Asst.*) *Chem.*
Frank O. Kreager, A. B., (*Asst.*) *Engl.*
Howard B. Berry, M. S., *Instr. Agron.*
Ira P. Whitney, B. S., *Instr. Dairying.*
Olive F. McKay, *Instr. Dom. Art.*
Leila W. Hunt, A. B., B. S., *Instr. Dom. Econ.*
Samuel W. Collett, M. S., *Instr. Bot.*

Christian H. Goetz, B. S., *Instr. For.*
Clare C. Todd, B. S., *Instr. Chem.*
Henry L. Walter, A. B., *Instr. Chem.*
Oscar M. Olson, *Instr. Farmers' Insts.*
Justinus J. L. Heldring, D. C. M., *Instr. Vet. Sci.; House Surgeon.*
K. A. Kirkpatrick, B. S. A., *Instr. Hort.*
Claude W. Lawrence, B. S., *Instr. Agron.*
Wm. G. Brierly, B. S. A., *Instr. Hort. (Inst. Worker).*
Chas. H. Schuele, B. S., *Instr. Chem.*
Josephine M. Hoeppner, Ph. G., B. S., M. A., *Instr. German.*
S. C. Roberts, B. S., *Instr. Phys.*
W. Blacklock, *Flor.*
W. D. Foster, *Supt. of Farm, Foreman of Agr. Dept.*
Asa D. Dickenson, *Libr.*
Stella M. Wilson, *Asst. Libr.*
Frank J. Barnard, B. S., *Registrar.*

Washington Agricultural Experiment Station, ***Pullman.***

Department of the State College of Washington, under the control of the Board of Regents.

STATION STAFF.

R. W. Thatcher, B. S., M. A., *Dir.; Chem.; Supt. of Farmers' Insts. and Ext. Work.*
Elton Fulmer, M. A., *State Chem.*
S. B. Nelson, D. V. M., *Vet.*
O. L. Waller, Ph. M., *Irrig. Engin.*
W. S. Thornber, M. S., *Hort.*
R. Kent Beattie, B. S., M. A., *Bot.*
A. L. Melander, M. S., *Ent.*
Geo. Severance, B. S., *Agron.*
C. W. Lawrence, B. S., *Cerealist.*
W. H. Lawrence, A. B., M. S., *Plant Path.; Supt. Substa., Puyallup.*
C. C. Thom, M. S. A., *Soil Phys.*
W. T. McDonald, M. S. A., *Animal Husb.*
H. B. Humphrey, Ph. D., *Plant Path.*
W. T. Shaw, B. Agr., M. S., *Asst. Zool.*
G. A. Olson, B. S. A., M. S., *Asst. Chem.*
Alex. Carlyle, *Asst. Cerealist.*
E. L. Peterson, B. S., *Asst. Soil Phys.*
Rex N. Hunt, M. S., *Asst. Bot.*
W. H. Hein, M. A., *Asst. Hort.*
W. L. Hadlock, B. S., *Asst. Chem.*
H. L. Blanchard, *Asst. Supt. Substa., Puyallup, in charge of Dairy and Poultry Invest.*
O. M. Olson, *Deputy Supt. of Farmers' Insts.*
H. W. Sparks, *Supervisor Demonstration Farms.*
W. D. Foster, *Supt. College Farm.*

WEST VIRGINIA.

College of Agriculture of West Virginia University, ***Morgantown.***

GOVERNING BOARD.

Board of Regents: M. P. Shawkey * (*Pres.*), *Charleston;* George S. Laidley,* *Charleston;* J. B. Finley,* *Parkersburg;* M. C. Lough,* *Fairmont;* G. A. Northcott,* *Huntington.*

COURSES OF STUDY.

The four-year courses with degrees are: All courses leading to general culture, B. A. and B. S.; course in mechanical engineering and electrical engineering, B. S. E. E., B. S. M. E.; course in civil engineering, B. S. C. E.; mining engineering, B. S. E. M.; scientific course in agriculture, B. S. Agr.; and the law course, LL. B. The following courses are also offered: Veterinary science (three years), leading to D. V. S.; agriculture (three years); domestic science (two years); law (two years); commercial (two years); agriculture (one year); preparatory, graduate, music, art, special courses; twelve weeks' courses in agriculture, horticulture, animal industry, poultry industry, and dairying; a special winter agricultural course of four weeks; and a six weeks' summer school.

BOARD OF INSTRUCTION.

Daniel B. Purinton, Ph. D., LL. D., *President of the University; Philosophy.*

Thomas C. Atkeson, Ph. D., *Dean Agr. College; Agr.*
Alexander R. Whitehill, Ph. D., *Gen. and Anal. Chem.; Treas.*
Jas. S. Stewart, M. S., *Math. Emeritus; Sec.*
John A. Eiesland, Ph. D., *Math.*
Samuel B. Brown, A. M., *Geol., Min.*
Albert M. Reese, Ph. D., *Zool.*
H. A. Eaton, A. B., LL. B., Capt., *Comdt. of Cadets; Mil. Sci.*
Arthur S. Graves, A. B., *Instr. German.*
Wm. J. Leonard, (*Assoc.*) *Fine Arts.*
E. W. Waggoner, Ph. D., *Phys.*
Wm. J. White, *Auditor.*
Robert A. Armstrong, A. M., L. H. D., *Engl. Lang. and Lit.*

Chas. H. Patterson, A. M., *Rhet.*
Bert H. Hite, M. S., *Agr. Chem.*
W. E. Rumsey, B. S. Agr., *Econ. Bot.*
W. M. Munson, Ph. D., *Hort.*
Alfred J. Hare, M. A., *Lat., Lit.; Prin. Prep. School; Registrar.*
Neva A. Scott, *Dom. Sci.*
Chas. A. Lueder, D. V. S., *Instr. Dairying and Animal Husb.*
John N. Simpson, A. M., M. D., *Anat., Physiol.*
Justin F. Grant, M. D., *Anat., Path.*
Frederick L. Kortright, D. Sc., *Chem.*
John L. Sheldon, Ph. D., *Bact., Plant Path., Bot.*
Frederick W. Truscott, Ph. D., *Germanic Lang. and Lit.*
Madison Stathers, Ph. D., *(Asst.) Romance Lang. and Lit.*
G. L. Crane, *(Asst.) Romance Lang.*
Horace Atwood, M. S. Agr., *Instr. Poultry Indus.*
A. W. Nolan, A. B., *(Asst.) Hort., For., Ent.*
Chas. W. Springer, V. M. D., *Instr. Vet Sci.*
F. R. Whipple, M. V. D., *Instr. Vet. Sci.*
C. C. Holden, M. A., *Instr. Romance Lang.*
Clarence Post, A. B., *Instr. Phys.*
D. W. Working, B. S., A. M., *Supt. Agr. Ext.*
Lucy E. Fay, A. B., B. L. S., *Libr.*
Fred'k L. Emory, M. E., *Supt. of Buildings and Grounds.*

West Virginia Agricultural Experiment Station, *Morgantown.*

Department of West Virginia University, under the control of the Board of Regents.

STATION STAFF.

J. H. Stewart, M. A., *Dir.; Agr.*
B. H. Hite, M. S., *V. Dir.; Chem*
W. M. Munson, Ph. D., *Hort.*
W. E. Rumsey, B. S. Agr., *Ent.*
Nahum J. Giddings, M. S., *Bact.*
Horace Atwood, M. S. Agr., *Asst. Agr.*
Frank B. Kunst, A. B., *Asst. Chem.*
Fred E. Brooks, *Assoc. Ent.*
A. L. Dacy, B. S., *Asst. Hort.*
J. H. Berghuis Krak, *Asst. Chem.*
Chas. E. Weakley, jr., *Asst. Chem.*
O. C. Beck, B. S., *Asst. Chem.*
H. E. Williams, *Special Agt. on Highways.*
Martha A. Stewart, *Libr.*
Thos. E. Hodges, *Treas.*

The West Virginia Colored Institute, *Institute.*

GOVERNING BOARD.

Board of Regents: M. P. Shawkey (*Pres.*), *Charleston;* Geo. S. Laidley, *Charleston;* M. C. Lough, *Fairmont;* G. A. Northcott, *Huntington;* J. B. Finley, *Parkersburg.*

COURSES OF STUDY.

The courses of study are: Agricultural, mechanical, normal and academic (requiring four years each for completion), and commercial, domestic science and art, and mechanics (requiring two years each for completion).

BOARD OF INSTRUCTION.

Byrd Prillerman, A. M., *President; English.*

S. H. Guss, A. B., *Prin. Normal Dept.; Lat., Chem.*
A. W. Curtis, M. Agr., *Dir. Agr. Dept.; Bot.*
Charles E. Jones, *Nat. Sci., Hist.; Sec.*
William A. Spriggs, *Carpentry.*
Mrs. Elizabeth M. Jones, *Music; Libr.*
Mary Eubank, *Head of Dept. of Dom. Sci. and Arts; Asst. Sec.*
James M. Canty, *Supt. of Mech. Indus.*
C. Ruth Campbell, *Cooking.*
W. H. Lowry, *Comdt. of Cadets; Math.*
Mrs. Margaret M. Lowry, *Millinery, Sew.*
Mrs. Emma A. Dorsey, *Matron.*
A. G. Brown, *Mech. and Free-hand Draw.*
Chas. E. Mitchell, M. A., *Head of Coml. Dept.; Business Mgr.*
Mrs. Maud Jackson, *Instr. Laundering.*
Fanny C. Cobb, *Normal Training.*
Jessie F. Embry, A. B., *German, Engl.*
I. R. Whipper, M. D., *Physiol.; Physician.*

WISCONSIN.

College of Agriculture of the University of Wisconsin, *Madison.*

GOVERNING BOARD.

Board of Regents: W. D. Hoard (*Pres.*), *Fort Atkinson;* D. P. Lamereaux, *Beaver Dam;* President of University * (*ex officio*), *Madison;* Chas. P. Cary (*State Supt. of Public Instr., ex officio*), *Madison;* A. H. Dahl (*ex officio, Treas.*), *Madison;* L. S. Hanks, *Madison;* J. F. Trottman, *Milwaukee;* Edward Evans, *La Crosse;* Magnus Swenson, *Madison;*

Pliny Norcross, *Janesville;* E. Lloyd-Jones, *Hillside;* F. C. Thwaits, *Milwaukee;* Mrs. Florence G. Buckstaff, *Oshkosh;* G. Keller, *Appleton;* A. P. Nelson, *Grantsburg;* G. D. Jones, *Wausau;* M. E. McCaffrey (*Sec.*), *Madison.*

COURSES OF STUDY.

The long courses in agriculture and home economics require four years, leading to the degree of B. S., the middle course in agriculture covers two years, and the short course covers two terms of fourteen weeks each. A certificate is granted to those completing these courses. The winter dairy course lasts twelve weeks and requires for admission one season's previous training in a creamery or cheese factory. A summer dairy course is offered to a limited number of students, who will be admitted without previous factory training and may remain the whole season. To secure a dairy certificate the student must have had two seasons' actual practice in a factory, one of which must follow his work at the dairy school. A two weeks farmers' course, limited to persons who are at least 25 years of age; a housekeeper's conference, and a week's special course for cheese factory and creamery operators and managers are also offered.

BOARD OF INSTRUCTION.[a]

Chas. Richard Van Hise, Ph. D., LL. D., *President of the University.*

H. L. Russell, Ph. D., *Dean College of Agr.*
Wm. A. Henry, D. Agr., D. Sc., *Agr. Emeritus.*
Stephen M. Babcock, Ph. D., LL. D., *Agr. Chem.*
D. H. Otis, M. S., *Farm Management; Asst. to Dean.*
Mazyck P. Ravenel, M. D., *Bact.*
Edward H. Farrington, M. S., *Dairy Husb.*
A. R. Whitson, B. S., *Soils and Drainage.*
Fritz W. Woll, Ph. D., *Agr. Chem.*
Edwin B. Hart, B. S., *Agr. Chem.*
Geo. C. Humphrey, B. S., *Animal Husb.*
Alexander S. Alexander, M. D. C., V. S., *Vet. Sci.; in charge of Dept. of Horse Breeding.*
Ransom A. Moore, *Agron.*
Henry C. Taylor, Ph. D., *in charge of Dept. of Agr. Econ.*
Wm. S. Marshall, Ph. D., (*Assoc.*) *Ent.*
K. L. Hatch, B. S. A., (*Asst.*) *Agr. Ed.; Sec. Ext. Work.*
Abby L. Marlatt, *in charge of Dept. of Home Econ.*
E. G. Hastings, M. S., (*Assoc.*) *Agr. Bact.*
J. L. Sammis, Ph. D., (*Asst.*) *Dairy Husb.*
Chas. W. Stoddart, Ph. D., (*Asst.*) *Soils.*
R. H. Denniston, Ph. G., Ph. D., (*Asst.*) *Bot.*
E. V. McCollum, Ph. D., (*Asst.*) *Agr. Chem.*
James G. Fuller, B. S. A., (*Asst.*) *Animal Husb.*
Charles A. Ocock, B. S., (*Asst.*) *Agr. Chem.*
James G. Moore, M. S., (*Asst.*) *Hort.*
Carl E. Lee, B. S., (*Asst.*) *Dairy Husb.*
James G. Halpin, B. S. A., (*Asst.*) *Poultry Husb.*
Edward R. Jones, M. S., (*Asst.*) *Soils and Drainage.*
W. G. Marquette, B. S., (*Asst.*) *Bot.*
C. P. Norgord, B. S. A., (*Asst.*) *Agron.*
J. Clyde Marquis, B. S. A., *Editor; Instr. Agr. Journalism.*
Gustav H. Benkendorf, *Instr. Dairy Husb.*
Wm. E. Tottingham, M. S., *Instr. Agr. Chem.*
Frank Kleinheinz, *Instr. Animal Husb.*
Alden L. Stone, *Instr. Agron.*
Conrad Hoffmann,[b] B. S. A., *Instr. Agr. Bact.*
James G. Milward, M. S. A., *Instr. Hort.*
A. J. Rogers, jr., M. S. A., *Instr. Hort.*
Harlow L. Walster, B. S. A., *Instr. Soils.*
W. W. Sylvester, B. S. A., *Instr. Agr. Engin.*
John L. Tormey, B. S. A., *Instr. Animal Husb.*
B. G. Smith, *Instr. Zool.*
Leona Hope, *Instr. Home Econ.*
Alice Loomis, *Asst. in Home Econ.*
J. J. Singler, *Asst. in Dairy Husb.*
Gottlieb Marty, *Asst. in Dairy Husb.*
Ward M. Totman, *Asst. in Dairy Husb.*
Louis Peterson, *Asst. in Dairy Husb.*
J. Accola, *Asst. in Animal Husb.*
O. J. Delwiche, *Asst. in Animal Husb.*
Edgar W. Fox, *Asst. in Animal Husb.*
B. W. Hammer, B. S. A., *Asst. in Agr. Bact.*
Shinkicki K. Suzuki, B. S., *Asst. in Agr. Chem.*
Harry Steenbock, B. S. A., *Asst. in Agr. Chem.*
H. Sandell, *Asst. in Soils.*
Louise M. Jahns, B. S., *Asst. in Soils.*
Fred L. Musback, B. S. A., *Asst. in Soils.*
J. F. Sievers, *Asst. in Soils.*
Emil Truog, B. S. A., *Asst. in Soils.*
Milton R. Gutsch, *Asst. in Ed.*
Louis U. St. Peter, *Asst. in Ed.*
James Johnson, B. S. A., *Asst. in Hort.*
John M. Napier, M. S., *Asst. in Agron.*
W. H. Peterson, M. A., *Asst. in Agr. Chem.*
Wm. H. Wright, M. S., *Asst. in Bact.*
Elmer E. Eldredge, B. S. A., *Asst. in Bact.*
Clarence S. Hean, B. A., *Libr.*

[a] Includes only instructors in subjects directly relating to agriculture. Many other members of the university faculty give instruction to agricultural students pursuing the course leading to the degree of B. S.

[b] On leave.

Agricultural Experiment Station of the University of Wisconsin, *Madison*.

Department of the University of Wisconsin, under the control of the Board of Regents.

STATION STAFF.

H. L. Russell, Ph. D., *Dir.*
W. A. Henry, D. Agr., D. Sc., *Agr. Emeritus.*
S. M. Babcock, Ph. D., LL. D., *Asst. Dir.; Chief Chem.*
E. H. Farrington, M. S., *Dairy Husb.*
M. P. Ravenel, M. D., *Bact.*
A. R. Whitson, B. S., *Soil Phys.*
G. C. Humphrey, B. S., *Animal Husb.*
F. W. Woll, Ph. D., *Agr. Chem.*
E. B. Hart, B. S., *Agr. Chem.*
R. A. Moore, *Agron.*
H. C. Taylor, Ph. D., *Agr. Econ.*
Abby L. Marlatt, *Home Econ.*
A. S. Alexander, M. D. C., V. S., *Vet., Horse Breeding.*
D. H. Otis, M. S., *Farm Management.*
C. A. Ocock, B. S., *Agr. Engin.*
E. G. Hastings, M. S., *Agr. Bact.*
P. P. Peterson, Ph. D., *Soils.*
J. G. Halpin, B. S. A., *Poultry Husb.*
C. W. Stoddart, Ph. D., *Asst. Soil Phys.*
J. L. Sammis, Ph. D., *Asst. Dairy Husb.*
C. E. Lee, B. S., *Asst. Dairy Husb.*
Jas. G. Moore, M. S., *Asst. Hort.*
Jas. G. Milward, M. S. A., *Asst. in Hort.*
W. E. Tottingham, M. S., *Asst. Agr. Chem.*
Jas. G. Fuller, B. S. A., *Asst. Animal Husb.*
J. C. Marquis, B. S. A., *Editor.*
A. L. Stone, *Asst. Agron.; State Seed Insp.*
C. P. Norgord, B. S. A., *Asst. Agron.*
E. R. Jones, M. S., *Asst. in Soils and Drainage.*
E. V. McCollum, Ph. D., *Asst. Agr. Chem.*
S. K. Suzuki, B. S., *Asst. Agr. Chem.*
Harry Steenbock, B. S. A., *Asst. Agr. Chem.*
A. J. Rogers, jr., M. S. A., *Asst. in Hort.; State Hort. Insp.*
G. H. Benkendorf, *Asst. Dairy Husb.*
Frank Kleinheinz, *Asst. Animal Husb.; Shepherd.*
W. E. Markey, *Asst. in Animal Husb.*
E. J. Delwiche, M. S. A., *Supt. Northern Wisconsin Agr. Substa., Ashland.*
J. Accola, *Asst. Animal Husb.*
O. J. Delwiche, *Asst. Animal Husb.*
L. R. Davies, B. S., *Asst. in Dairy Tests, Fert., and Feed Insp.*
J. J. Singler, *Asst. Dairy Husb.*
O. G. Malde, *Asst. in Cranberry Invest., Grand Rapids.*
Gottlieb Marty, *Asst. Dairy Husb.*
H. L. Walster, B. S. A., *Asst. in Soils.*
Louise M. Jahns, B. S., *Asst. in Soil Survey.*
Emily M. Bresee, B. A., *Asst. Chem. Fert. and Feed Insp.*
J. L. Tormey, B. S. A., *Asst. Animal Husb.*
J. M. Napier, M. S., *Asst. Agron.*
W. H. Peterson, M. A., *Asst. Agr. Chem.*
James Johnson, B. S. A., *Asst. in Hort.*
J. F. Sievers, *Asst. in Soils.*
Emil Truog, B. S. A., *Asst. in Soils.*
W. W. Weir, B. S., *Asst. in Soils.*
W. M. Totman, *Asst. in Dairying.*
W. H. Wright, M. S., *Asst. Bact.*
E. E. Eldredge, B. S. A., *Asst. Agr. Bact.*
J. C. Jurrjens, *Asst. in Fert. and Feed Insp.*
W. E. Morris, B. S., *Asst. in Fert. and Feed Insp.*
W. W. Sylvester, B. S., *Asst. in Agr. Engin.*
Frank White, B. S., *Asst. in Agr. Engin.*
Leona Hope, *Asst. in Home Econ.*
Fred Welfenbach, *Foreman in Hort.*
George Hutton, *Farm Foreman.*
C. S. Hean, B. A., *Libr.*

WYOMING.

College of Agriculture and Mechanic Arts of the University of Wyoming, *Laramie*.

GOVERNING BOARD.

Board of Trustees: Otto Gramm * (*Pres.*), *Laramie;* T. F. Burke (*V. Pres.*), *Cheyenne;* F. S. Burrage (*Sec.*), *Laramie;* J. F. Crawford, *Saratoga;* A. C. Jones * (*Treas.*), *Laramie;* Gibson Clark, *Cheyenne;* Elizabeth A. Stone, *Evanston;* V. J. Tidball,* *Laramie;* H. A. Coffeen, *Sheridan;* A. J. Mokler, *Casper;* A. D. Cooke (*State Supt. of Public Instr., ex officio*), *Cheyenne;* Charles O. Merica * (*Pres. Univ., ex officio*), *Laramie.*

COURSES OF STUDY.

The following courses are offered, viz: Four-year agricultural, mechanical engineering, mining engineering, irrigation engineering, and home economics (B. S.); one and two year courses, and a twelve weeks' course in agriculture; two weeks' courses in agriculture, irrigation, live-stock management and judging; correspondence courses, and a six weeks' summer school for teachers.

BOARD OF INSTRUCTION.

Charles O. Merica, A. M., LL. D., ***President of the University; English.***

J. D. Towar, M. S., ***Agr.***
Aven Nelson, Ph. D., ***Biol.***
Henry Merz, A. M., ***Mod. Lang.***
Charles B. Ridgaway, A. M., ***Math.***
Arthur E. Bellis, M. S., ***Phys.***
Agnes M. Wergeland, Ph. D., ***Hist.***
Helen Middlekauff, ***Engl.***
Henry G. Knight, A. M., ***Chem.***
Fred W. Heyl, Ph. D., ***Asst. in Chem.***
Grace R. Hebard, Ph. D., ***Polit.; Libr.***
E. G. Hoefer, B. S., ***Mech. and Elect. Engin.***
Harol D. Coburn, Lieut., U. S. A., ***Mil. Sci. and Tactics; Dir. Phys. Training.***
Minna A. Stoner, B. S., ***Adviser for Women; House Econ.***
Lotta A. Crawford, B. S., ***Asst. in Household Econ.***
Albert C. Dart, B. S., ***Geol.***
J. R. Hutchison, B. S., ***School of Commerce.***
John C. Fitterer, B. S., C. E., ***Civil and Irrig. Engin.***
Otto L. Prien, M. D. V., ***Vet. Sci.***
Leslie B. McWethy, B. S., ***Agron.***
Alpheus D. Faville, B. S., ***Animal Husb.***
Robert J. Cowper, ***Asst. in Industrials.***
Chas. J. Oviatt, ***Asst. in Wool Invest.***

Wyoming Agricultural Experiment Station, ***Laramie.***

Department of the University of Wyoming, under the control of the Board of Trustees.

STATION STAFF.

J. D. Towar, M. S., ***Dir.; Agr., Hort.; in charge of Farmers' Insts.***
Aven Nelson, Ph. D., ***Bot.***
H. G. Knight, A. M., ***Chem.***
Grace R. Hebard, A. M., Ph. D., ***Sec.***
J. C. Fitterer, B. S., C. E., ***Irrig. Engin.***
L. B. McWethy, B. S., ***Agron.***
A. D. Faville, B. S., ***Animal Husb.***
John A. Hill, B. S., ***Wool Specialist.***
O. L. Prien, M. D. V., ***Vet.***
L. Charles Raiford, Ph. D., ***Research Chem.***
Frank E. Hepner, Ph. G., M. S., ***Asst. Agr. Chem.***
A. E. Bellis, A. B., ***Met.***

INDEX OF NAMES.

THE AGRICULTURAL COLLEGES.

ALABAMA—*Auburn:* Charles C. Thach.[a] *Normal:* W. L. Buchanan.[a] *Tuskegee Institute:* Booker T. Washington.[b]

ARIZONA—*Tucson:* Kendric C. Babcock.[a]

ARKANSAS—*Fayetteville:* J. N. Tillman.[a]

CALIFORNIA—*Berkeley:* Benjamin Ide Wheeler.[a]

COLORADO—*Fort Collins:* Chas. A. Lory.[a]

CONNECTICUT—*Storrs:* C. L. Beach.[a]

DELAWARE—*Newark:* Geo. A. Harter.[a] *Dover:* W. C. Jason.[a]

FLORIDA—*Gainesville:* A. A. Murphree.[a] *Tallahassee:* Nathan B. Young.[a]

GEORGIA—*Athens:* Andrew M. Soule.[a] *Savannah:* R. R. Wright.[a]

HAWAII—*Honolulu:* J. W. Gilmore.[a]

IDAHO—*Moscow:* J. A. MacLean.[a]

ILLINOIS—*Urbana:* E. J. James.[a]

INDIANA—*Lafayette:* Winthrop Ellsworth Stone.[a]

IOWA—*Ames:* Albert Boynton Storms.[a]

KANSAS—*Manhattan:* H. J. Waters.[a]

KENTUCKY—*Lexington:* J. K. Patterson.[a] *Frankfort:* J. H. Jackson.[a]

LOUISIANA—*Baton Rouge:* Thos. D. Boyd.[a] *New Orleans:* H. A. Hill.[a]

MAINE—*Orono:* George Emory Fellows.[a]

MARYLAND—*College Park:* R. W. Silvester.[a] *Princess Anne:* Frank Trigg.[b]

MASSACHUSETTS—*Amherst:* Kenyon L. Butterfield.[a]

MICHIGAN—*East Lansing:* J. L. Snyder.[a]

MINNESOTA—*St. Anthony Park, St. Paul:* Cyrus Northrop.[a]

MISSISSIPPI—*Agricultural College:* J. C. Hardy.[a] *Alcorn:* L. J. Rowan.[a]

MISSOURI—*Columbia:* Albert R. Hill.[a] *Jefferson City:* B. F. Allen.[a]

MONTANA—*Bozeman:* Jas. M. Hamilton.[a]

NEBRASKA—*Lincoln:* Samuel Avery.[c]

NEVADA—*Reno:* Joseph E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* Wm. D. Gibbs.[a]

NEW JERSEY—*New Brunswick:* W. H. S. Demarest.[a]

NEW MEXICO—*Agricultural College:* W. E. Garrison.[a]

NEW YORK—*Ithaca:* H. J. Webber.[d]

NORTH CAROLINA—*West Raleigh:* D. H. Hill.[a] *Greensboro:* James B. Dudley.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Columbus:* William Oxley Thompson.[a]

OKLAHOMA—*Stillwater:* J. H. Connell.[a] *Langston:* Inman E. Page.[a]

OREGON—*Corvallis:* W. J. Kerr.[a]

PENNSYLVANIA—*State College:* Edwin E. Sparks.[a]

RHODE ISLAND—*Kingston:* Howard Edwards.[a]

SOUTH CAROLINA—*Clemson College:* W. M. Riggs.[e] *Orangeburg:* Thomas E. Miller.[a]

SOUTH DAKOTA—*Brookings:* R. L. Slagle.[a]

TENNESSEE—*Knoxville:* Brown Ayres.[a]

TEXAS—*College Station:* R. T. Milner.[a] *Prairieview:* E. L. Blackshear.[b]

UTAH—*Logan:* J. A. Widtsoe.[a]

VERMONT—*Burlington:* M. H. Buckham.[a]

VIRGINIA—*Blacksburg:* P. B. Barringer.[a] *Hampton:* H. B. Frissell.[b]

WASHINGTON—*Pullman:* E. A. Bryan.[a]

WEST VIRGINIA—*Morgantown:* D. B. Purinton.[a] *Institute:* Byrd Prillerman.[a]

WISCONSIN—*Madison:* Chas. Richard Van Hise.[a]

WYOMING—*Laramie:* Chas. O. Merica.[a]

[a] President. [b] Principal. [c] Chancellor. [d] Acting dean. [e] Acting president.

OFFICIALS IN CHARGE OF FARMERS' INSTITUTES.

ALABAMA.—C. A. Cary, professor of veterinary science, Polytechnic Institute, Auburn; T. M. Campbell, district agent farmer's cooperative demonstration work, Tuskegee Institute.
ALASKA.—C. C. Georgeson, agricultural experiment station, Sitka.
ARIZONA.—R. W. Clothier, superintendent farmers' institutes, Tucson.
ARKANSAS.—George A. Cole, superintendent farmers' institutes, Fayetteville.
CALIFORNIA.—W. T. Clarke, superintendent farmers' institutes, Berkeley; J. B. Neff, conductor of farmers' institutes in southern California, Anaheim.
COLORADO.—H. M. Cottrell, director farmers' institutes, Fort Collins.
CONNECTICUT.—I. C. Fanton, secretary state board of agriculture, Westport; J. G. Schwink, jr., secretary Connecticut Dairymen's Association, Meriden; H. C. C. Miles, secretary Connecticut Pomological Society, Milford.
DELAWARE.—Wesley Webb, secretary board of agriculture, Dover.
FLORIDA.—P. H. Rolfs, director agricultural experiment station, Gainesville.
GEORGIA.—A. M. Soule, president State College of Agriculture, Athens.
HAWAII.—Wm. Weinrich, jr., secretary and treasurer farmers' institutes, Box 881, Honolulu.
IDAHO.—W. L. Carlyle, director agricultural experiment station, Moscow.
ILLINOIS.—Frank H. Hall, secretary Illinois farmers' institutes, Aurora.
INDIANA.—W. C. Latta, professor of agriculture in Purdue University, Lafayette.
IOWA.—J. C. Simpson, secretary state board of agriculture, Des Moines.
KANSAS.—J. H. Miller, superintendent farmers' institutes, Manhattan.
KENTUCKY.—M. C. Rankin, commissioner of agriculture, Frankfort.
LOUISIANA.—Charles Schuler, commissioner of agriculture, Baton Rouge.
MAINE.—A. W. Gilman, commissioner of agriculture, Augusta.
MARYLAND.—W. L. Amoss, director farmers' institutes, Benson.
MASSACHUSETTS.—J. L. Ellsworth, secretary state board of agriculture, Boston.
MICHIGAN.—L. R. Taft, superintendent farmers' institutes, East Lansing.
MINNESOTA.—A. D. Wilson, director farmers' institutes, St. Anthony Park.
MISSISSIPPI.—E. R. Lloyd, director farmers' institutes, Agricultural College.
MISSOURI.—T. C. Wilson, secretary state board of agriculture, Columbia.
MONTANA.—F. B. Linfield, director agricultural experiment station, Bozeman; F. S. Cooley, superintendent farmers' institutes, Bozeman.
NEBRASKA.—Val Keyser, assistant superintendent farmers' institutes, Lincoln.
NEVADA.—J. E. Stubbs, president Nevada State University, Reno.
NEW HAMPSHIRE.—N. J. Bachelder, secretary state board of agriculture, Concord.
NEW JERSEY.—Franklin Dye, secretary state board of agriculture, Trenton.
NEW MEXICO.—John D. Tinsley, superintendent farmers' institutes, Agricultural College.
NEW YORK.—R. A. Pearson, commissioner of agriculture, Albany.
NORTH CAROLINA.—T. B. Parker, director farmers' institutes, Raleigh.
NORTH DAKOTA.—T. A. Hoverstad, superintendent farmers' institutes, Fargo.
OHIO.—J. P. Sandles, secretary State board of agriculture, Columbus.
OKLAHOMA.—J. C. Elliott, superintendent farmers' institutes, Guthrie.
OREGON.—J. Withycombe, director agricultural experiment station, Corvallis.
PENNSYLVANIA.—A. L. Martin, deputy secretary of agriculture, Harrisburg.
PORTO RICO.—D. W. May, agricultural experiment station, Mayaguez.
RHODE ISLAND.—John J. Dunn, secretary state board of agriculture, Providence.
SOUTH CAROLINA.—D. N. Barrow, professor of agriculture, Clemson College.
SOUTH DAKOTA.—A. E. Chamberlain, superintendent farmers' institutes, Brookings.
TENNESSEE.—John Thompson, commissioner of agriculture, Nashville.
TEXAS.—J. M. Neill, director farmers' institutes, Austin.
UTAH.—L. A. Merrill, superintendent of farmers' institutes, Salt Lake City.
VERMONT.—O. L. Martin, commissioner of agriculture, Plainfield.
VIRGINIA.—G. W. Koiner, commissioner of agriculture, Richmond.
WASHINGTON.—R. W. Thatcher, superintendent farmers' institutes, Pullman.
WEST VIRGINIA.—Charles McIntire, superintendent farmers' institutes, Charleston.
WISCONSIN.—G. B. McKerrow, director farmers' institutes, Madison.
WYOMING.—J. D. Towar, director agricultural experiment station, Laramie.

DIRECTORS OF FARMERS' INSTITUTES OF CANADA.

ALBERTA.—H. A. Craig, superintendent of farmers' institutes, Edmonton.
BRITISH COLUMBIA.—R. W. Hodson, live stock commissioner, Victoria.
MANITOBA.—W. J. Black, deputy minister of agriculture, Winnipeg.
NEW BRUNSWICK.—Thos. A. Peters, deputy minister of agriculture, Fredericton.
NOVA SCOTIA.—M. Cumming, secretary of agriculture, Truro.
ONTARIO.—G. A. Putnam, director of farmers' institutes, Toronto.
PRINCE EDWARD ISLAND.—S. E. Reid, commissioner of agriculture, Charlottetown.
QUEBEC.—G. A. Gigault, deputy minister of agriculture, Quebec.
SASKATCHEWAN.—F. Hedley Auld, superintendent fairs and institutes, Regina.

1252 Issued May 3, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN 225.

A. C. TRUE, Director.

PROCEEDINGS

OF THE FOURTEENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF

FARMERS' INSTITUTE WORKERS,

HELD AT

PORTLAND, OREG., AUGUST 16, 17, 1909.

EDITED BY

W. H. BEAL, for the Office of Experiment Stations,

AND

JOHN HAMILTON, for the Association.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1910.

OFFICE OF EXPERIMENT STATIONS.

A. C. True, Ph. D., Sc. D., Director.
E. W. Allen, Ph. D., Assistant Director and Editor of Experiment Station Record.
John Hamilton, B. S., M. S. A., Farmers' Institute Specialist.
J. M. Stedman, B. S., Assistant Farmers' Institute Specialist.

[Bull. 225]

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., February 1, 1910.

SIR: I have the honor to transmit herewith, and to recommend for publication as Bulletin 225 of this Office, a report of the proceedings of the fourteenth annual meeting of the American Association of Farmers' Institute Workers, held at Portland, Oreg., August 16 and 17, 1909.

Respectfully,

A. C. TRUE,
Director.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

OFFICERS AND COMMITTEES OF THE ASSOCIATION.

President.
G. A. PUTNAM, Toronto, Ontario.

Vice-President.
A. M. SOULE, Athens, Ga.

Secretary-Treasurer.
JOHN HAMILTON, Department of Agriculture, Washington, D. C.

Executive Committee.

The PRESIDENT and the SECRETARY-TREASURER, ex officio; W. T. CLARKE, Berkeley, Cal., Chairman; VAL KEYSER, Lincoln, Nebr.; FRANKLIN DYE, Trenton, N. J.

STANDING COMMITTEES.

Institute organization and methods.

	Term expires.
J. D. Tinsley, Agricultural College, N. Mex., chairman	1910
J. H. Connell, Stillwater, Okla	1911
W. C. Latta, La Fayette, Ind	1912

Institute lecturers.

T. A. Hoverstad, Fargo, N. Dak., chairman	1910
B. Walker McKeen, Fryeburg, Me	1911
D. W. Working, Morgantown, W. Va	1912

Cooperation with other educational agencies.

George McKerrow, Madison, Wis., chairman	1910
G. C. Creelman, Guelph, Ontario, Canada	1911
K. L. Butterfield, Amherst, Mass	1912

Movable schools of agriculture.

Alva Agee, State College, Pa., chairman	1910
L. R. Taft, East Lansing, Mich	1911
L. A. Merrill, Salt Lake City, Utah	1912

Boys' and girls' institutes.

A. E. Chamberlain, Brookings, S. Dak., chairman	1910
F. H. Rankin, Urbana, Ill	1911
Val Keyser, Lincoln, Nebr	1912

Women's institutes.

Mrs. F. L. Stevens, Raleigh, N. C., chairman	1910
Miss Martha Van Rensselaer, Cornell University, Ithaca, N. Y	1911
Miss Laura Rose, Guelph, Ontario, Canada	1912

PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

MORNING SESSION, MONDAY, AUGUST 16, 1909.

The association was called to order in the Commercial Club Building at 10 o'clock a. m. by the president of the association, J. L. Ellsworth, of Massachusetts.

After the transaction of routine business, the convention adjourned until 2 p. m.

AFTERNOON SESSION, MONDAY, AUGUST 16, 1909.

The convention was called to order at 2 p. m. by the president, who delivered the annual address, as follows:

PRESIDENT'S ADDRESS.

The particular point on which I wish to touch at first is a tendency, which I am sure exists, and which I believe to be a wrong one—a tendency which, if not checked, will be a great detriment to the farmers' institute movement. I refer to the tendency to centralization, to taking the management of these meetings out of the hands of the working farmers and to placing them entirely under the control of the state bureaus or agricultural colleges and experiment stations. The theory upon which this development has gone has been, in the main, that the institute should be strictly educational in its aims, that it should instruct and instruct alone, and that there were others better fitted than the farmers themselves to bend these meetings in the right direction and see that the proper sort of instruction should be given. To the first part of this theory I most heartily subscribe. The institute should be strictly educational in its aims, and all subjects other than agricultural should be excluded from its programs. The mischief lies, as I believe, in the second part of the proposition. Here I must be careful to make myself clear, else I shall undoubtedly hurt the feelings of some very excellent gentlemen who are as thoroughly interested in the welfare of farmers' institutes as are any of us. I have no doubt that, from a pedagogic standpoint, the people are right who hold that the farmers can not control these meetings and arrange the programs for them to as good advantage as can others more thoroughly trained in teaching and in scientific work. But I fear that some who have held that view have in their enthusiasm gone too far and undertaken to make sure that the farmers are properly instructed with such firmness that they have in a measure checked the interest which the farmers should take in these meetings.

I am a firm believer in the necessity of local cooperation, local enthusiasm, local management, to get the best results from institute meetings. It may be that the farmers of a locality do not appreciate as thoroughly what they should be instructed in as do those who have general charge of the meetings for the State or Province; nevertheless it seems certain that a committee of hard-headed farmers will know better what the people of their locality want to hear about, what they are interested in, than some one at a distance. It is well to remember, in planning for your farmers' institutes, that you are dealing with a peculiar and cautious people; that the farming population is made up in the main of men of very decided ideas, and perhaps prejudices; that they are conservative, ultra conservative, and the hardest people in the world to make change an opinion when once formed. If the matter which is sought to be brought to their attention is one of the utmost importance to them, they will be very likely, as a class, to neglect it until such time as they can take it up in their own way.

I believe, therefore, that the ideal arrangement is for the local management of the institutes to be in the hands of some farmers' organization already in existence at the time the institute work is inaugurated, and not one especially prepared to take charge of the institute work and organized and fathered by the state official in charge of the work. Let this local organization take charge of making up the program for the year, let them select their subjects, with such guidance as seems necessary and safe, and let them have a share in the financial burdens of the institute system. Almost any organization will be glad to defray the local expenses of hall, heating and lighting the same, and advertising, if asked to do so, and such participation is a great thing in making them feel that the meeting is their own. It has the additional advantage in most cases of doubling the effectiveness of the state funds and making it possible to hold twice as many meetings as would otherwise be the case.

It may be objected that if the local people are allowed such full swing they will rush off at various tangents and insist on discussing subjects which do not pertain to agriculture, and which are perhaps not needed in their sections, but experience has not shown that this is the case. Further, it is the easiest thing in the world to check any such tendency when it manifests itself. The state official in charge, if he is wise and tactful, can readily establish a sufficient ascendency over the local managers and committees so that they will follow his advice whenever he feels that it is incumbent on him to offer it. If he is tactful, he will not push forward too often, nor attempt to advise on immaterial matters, to the end that when he does offer his advice it will be listened to with respect and followed whenever he finds it desirable to intervene.

In regard to the official in charge of the institute work for the State or Province, it is my belief that he should be from the farm, and a practical farmer rather than a teacher, when it is not possible to combine the two. He should, of course, be a man who understands the problems of the farm and who is, in addition, where possible, well posted on educational matters. This combination is not as frequently met with as many seem to believe. It is my opinion that where we must choose between a man who is strong on the practical side, on the side of the farm and the farming class and understanding their problems and point of view, and one who is strong on the educational side, and in understanding what the farmers should be instructed on and how it should be done, from a school standpoint, we would do well to choose the former. He will make his mistakes, but they will not be serious ones.

It should not be lost sight of that the farmers' institute is primarily for the instruction of the adults of both sexes, and for those who can not avail themselves of even the short courses offered by our agricultural colleges. This instruction can not, even under the most favorable circumstances, be systematic to the degree that that given in regular classes is systematic, and the tendency of the school man, who is not well grounded on the practical end, is to make it too systematic, too much like that of the class room. It must strike the golden mean between the class room and the general lecture platform, where the aim is as much to amuse as to instruct, and to do this a very broad outlook is required.

Special kinds of institutes for special classes of the farming population, women's institutes, where household matters are discussed, and perhaps meetings for boys and girls, must not be neglected, and in these special lines of work the general rule above stated, that the institute is for the instruction of the adult farmer, will have to give way to the special needs of the case. Nevertheless, that is its main function, and the man who is charged with the oversight of the work must be one who is thoroughly in sympathy with that phase. If he is to be a specialist in any branch he should be a specialist in that sort of work, but the best combination is a man who can carry out this line and still have breadth of mind and grasp sufficient to meet other problems out of the beaten track as they arise.

Given the proper man to assume the direct responsibility of the work, the question of whether it is under the state department of agriculture or the college or experiment station becomes a minor one. Nevertheless, it is my belief, founded on a fairly close observation of the situation, that better results will be achieved, on the average, where the institutes are controlled by the state departments, boards of agriculture, or commissioners of agriculture, than where the control is in other hands, for the reason that they are then generally in closer touch with the farmers and their conditions. This supposes, of course, a fairly strong and representative department of agriculture in the State or Province, one that has the confidence of the farming community. In any event, I am disposed to believe that best results are obtained, on the whole, where the appointing power is outside of the officers of the government who are elected by the vote of the people at the state elections. Let the appointing body be as representative of the agricultural community as possible, but in particular be sure that the office of director of farmers' institutes, whether called by that name

or some other, is entirely divorced from partisan politics and kept out of the hands of the professional officeholder. To make that office a reward for holding the farmer vote in line is one sure way to cripple the work and retard its development.

On the practical features of the institutes themselves I have little comment to make. I am a strong believer in demonstration work and think that it has been too much neglected by our farmers' institute managers in general. The speaker who uses some form of this sort of illustration, even if it be only the chart or blackboard, usually scores a most distinct hit in the way of awakening and holding the attention of his audience, than does he who depends upon the spoken word alone. The demonstrations, where given, should be of a simple nature, such that the audience can readily see and comprehend what is being done. Long and complex operations, where the audience is carried through many successive steps of detail work, become wearisome and tend to divert the mind from the question under consideration. Here, as elsewhere, practice is a great aid in making the demonstration effective, and what appears at first to be absolutely undemonstrable may, with attention and experiment, be found to be the very thing where an interesting demonstration is possible.

The Massachusetts state board held a demonstration meeting the first week of the current month at which demonstrations were given of how to produce and put up certified and steamer milk, of the best methods of selecting apples for exhibition, and the proper methods of judging fruit and box packing, and of the best methods of selecting, breeding, and judging corn. This program was one of the best, and I think it safe to say, the best ever arranged for a meeting in that State, as it took up the three topics that are now foremost in the minds of the farmers—milk, apples, and corn—and presented them in an absolutely new way. The meeting was a great success, both from the standpoint of the interest awakened and the attendance obtained, and from that of the actual instruction given. We were fortunate enough to be able to put out absolutely new work on the lines which our farmers were most generally discussing, and the result was an instant appreciation and enthusiasm. I mention this meeting, not because it is in any way peculiar to Massachusetts, or because it is a new method or the subjects new to the country at large, but because it forms an excellent illustration of what I believe to be the prime requisite to success in institute work. That is giving the people the subjects that most interest them, and which are at the same time strictly agricultural or pertaining thereto, and giving them in such a way as to combine to the highest degree the awakening of interest, curiosity, if you will, and the giving of practical instruction.

There are other matters worthy of consideration. Now, there is the question of good roads being brought out at present, in which Massachusetts is probably the pioneer. That State has expended in the last ten or twelve years between seven and ten millions of dollars, and is going ahead from one end of the State to the other continuously, from the coast to the west line and along the shore. Good roads is something that should be taken up, for farmers are the principal users of roads, and the better the roads the better the condition of the country.

Now, there is another problem, the insect problem, and it is a very serious matter in Massachusetts. It is serious anywhere. We have the San José scale; we have the gipsy and the brown-tail moth; we have the codling moth; and all those other things that destroy the apple crop. The gipsy and brown-tail moth have been in Massachusetts for the last thirty years, and it has cost the State to-day, including what the State, municipalities, and individuals pay, about one million dollars a year. Under the game protection laws of Massachusetts the deer are becoming a serious nuisance. Those problems ought to be studied, and studied carefully, and if you can meet them when they first come here it is the thing to do. Such problems ought to be brought before the farmers.

Industrial education has probably interested Massachusetts people more than it has some other people, because it is a great manufacturing State. This, of course, is not carried on in any way by the agricultural colleges. We are starting out there by having an educational industrial commission and it is putting these schools in the larger cities.

In conclusion, I would say to you to keep your institutes separate from other forms of agricultural instruction as far as possible. Make them a distinct and separate educational factor, rather than a side show to some other form of agricultural education or some other department of the Government. By so doing you will place them upon their own feet and insure their standing alone; you will place them where they must sink or swim on their own merits, and you will force them into a prominence, where, if they are successful, as they surely must be, they will attract more attention from the lawmaking bodies than if they are subordinate agencies, and so receive greater support, both financial and otherwise. If possible, see that a separate appropriation

is made by the state legislatures for the farmers' institutes. Make them a department by themselves and you will force them to take the position that rightfully belongs to them in the eyes of the lawmakers and the public in general.

The president's report was referred to the committee on president's address consisting of D. P. Witter, of New York; O. M. Olson, of Washington; and L. A. Merrill, of Utah. (See p. 48.)

The five-minute reports from the several States, Territories, and Provinces were then presented. (See p. 46.)

George A. Putnam, of Toronto, Canada, chairman of the committee, presented the following report:

REPORT OF COMMITTEE ON INSTITUTE ORGANIZATION AND METHODS.

"Farmers' institutes," as generally understood, include all meetings of farmers at which addresses on agricultural topics, exchange of farm experiences, or demonstrations on agricultural matters form the basis of instruction—from the exchange of opinions and experiences of farmers across the line fence to a conference of practical and scientific men upon matters of prominence and importance in the agricultural world. There are about as many methods of work and systems of organization as we have States and Provinces represented in this international association. While many of these have features of similarity in their regulations, details must be worked out in accordance with varying agricultural practice and possibilities as well as the nature of the people among whom we have to work. It would be unprofitable to attempt to review the rules and regulations governing institute work in different localities. Information regarding different methods of organization can be had from the secretary, who has published for our benefit a clear statement as to the different kinds of organization. The time can best be occupied upon this occasion in enumerating some of the essentials in successful institute work, rather than setting forth various methods of organization. The methods by which these essentials can be attained must be worked out in the light of a knowledge of the people and the conditions to be dealt with. Among the essentials to success may be mentioned the following:

Definite and constant source of revenue.—It is to be regretted that in a few States and Provinces there is no assurance that the institute work will be liberally supported from year to year, and in some localities the institute work is hampered by this uncertainty. Sometimes a decrease of available funds as compared with previous years is found. It is believed that no money voted by legislatures tells more in the real advancement of the country, both socially and financially, than that devoted to institute work. For the most part, the expenditures are carefully planned and economically administered. If it were possible to estimate the additional returns to the farmers on account of the introduction of improved methods as a result of institute lectures and literature, it would no doubt be shown that the comparatively small amount expended in this line of agricultural education had been returned to the farmers and country many-fold.

Assistance from local sources.—If people receive something for nothing, those benefited do not usually appreciate the service rendered so fully as they would were they asked to contribute in time, money, or influence in support of the work in hand. This applies specially in institute work. If people are asked to contribute a small collection, subscription, or the free use of a public hall for the meeting, it is likely that a deeper interest will be taken by the persons who are not only participating in the benefits but who are also contributing to the cost.

Creation of local interest.—Endeavor to secure the cooperation of well and favorably known local men prominent in agricultural, educational, and business circles. When it is known by the farmers of a community that such and such a leading agriculturist, prominent business man, or successful educator is in sympathy with the work and is lending his support to the same, a general support from the rank and file of the farmers can be expected. An effort should be made to impress upon the business men that success in the farming operations of the community means increased trade for them and tends more to the general prosperity to the community than the success of any other one class.

Enlisting the cooperation of the boys and young men.—Use methods of work which will attract the attention and enlist the sympathies and cooperation of the boys and young men. To attract and hold the attention of the boy or young man one must be a forceful and pleasing platform speaker, not only a teacher but an entertainer. It is difficult

for the average practical man (and we must have practical men for institute work) to appear before an audience as an entertainer. We must endeavor to enlist the cooperation of the young people by some other means than the giving of attractive addresses. Direct the boys and young men as to how they may undertake certain experimental work or attract them by the holding of demonstrations or exhibitions. If they can be induced to bring to the place of meeting samples of produce raised on their own farms and compare the same with other crops grown in the locality, it will be both interesting and instructive and an inspiration to more systematic and aggressive work in the future. If some of the young men can be induced to take part in the discussions or in debates held from time to time, a good start is made toward enlisting them as active workers in the institute.

Importance of small meetings in out-of-the-way places.—The tendency in modern methods is probably to centralize excessively. When conventions or meetings are held in central places it is likely, so far as farmers' meetings are concerned, to attract the men who are already progressive and up-to-date. The aim should be rather to take information direct to the doors of the men who have not as yet responded to the teachings of the college and the institute. Apparently the only way to reach and benefit these people is to go to their very doors and either teach by word of mouth or demonstrate in some forceful manner, which can not but be beneficial to the farmer were he only to apply such teaching to his local conditions. We must aim to reach the man who is most in need of assistance.

Local organizations.—These organizations should arrange for meetings to be held regularly throughout the greater portion of the year, and to be addressed chiefly by local men. If the farmers of a locality can be induced to plan for, and carry out, definite programs, bearing upon agricultural topics, from month to month, the result will be an organization which will assist most effectively in making the meeting or meetings to be addressed by representatives from the Department of Agriculture a decided success. Every encouragement should be given to local organizations.

Changes in institute organization.—Among the changes in institute organization, so far as some of the individual States are concerned, is noted a growing tendency on the part of some which have not yet done so, to form county or district organizations. The desirability of such local organizations has been recognized by the majority of the States for some time and experience would indicate that this method or something corresponding to it is essential to the best work. In some localities it has been thought well to make the institute districts smaller, thus making it possible for the officers to keep in closer touch with the requirements and desires of the different sections.

It is a hopeful sign of the times to see the institutes cooperate with high schools to a greater extent from year to year. The holding of short winter courses through the cooperation of the school and the institute is becoming more and more general.

Several States have for the first time engaged a special man to precede the deputation for the purpose of advertising and creating an interest in meetings to be held.

NEW FEATURES.

Much has been accomplished by the old methods of work and it is not advisable to abandon these but rather to supplement them with features which have proven effective in making the work of the institute of greater value to the farmer. In correspondence with the superintendents of institutes, something has been learned as to the new features of work which are proving effective; and from a survey of the situation it is possible with confidence to make definite recommendations along a few lines.

Among the new features of work which have been sufficiently well tried to insure their practicability in a number of States and Provinces may be mentioned the following:

Farmers' clubs.—Several States of the Union and two or three of the Provinces have already proven to their own satisfaction that most effective work can be done by and through local clubs. The number of these organizations has increased during the past year, and, judging by the enthusiasm with which superintendents speak of the work, the greatest activity in this department of institute work may be expected.

There is little hope for the institute of the future, or for agricultural education, unless we can induce the farmers in each locality to form themselves into societies for the discussion of the needs of the locality and through which an application of underlying principles to the conditions met with can best be made. After all, the theories, scientific facts, and results of experimental work as taught at our colleges and experiment stations and through the institute must be applied by the practical farmer upon his own farm if the desired results are to be attained. We lay great stress upon the opinions and statements and teachings of the practical farmer who makes a study of

the agricultural literature, which is now distributed in such large quantities, as well as the standard works on agriculture and the agricultural press.

Judging classes.—Short courses in stock and seed judging are becoming more and more prominent, and the States and Provinces are recognizing the possibilities in this line of work. It is a means whereby the farmer and his sons can be most effectively taught as to the desirable types of various classes of farm stock, the essentials of good seed, the importance of soil moisture, etc. It affords an opportunity for pointing out the defects of the stock of the community as well as an opportunity for advising as to how the stock may best be improved. By having a few desirable types of animals at the judging classes, impressive lessons can be given in selection and breeding.

Display of agricultural products and women's work.—Whether this line of work is taken up at an institute meeting, a meeting of the local club, or at the time of the fall exhibition, is of little consequence, so long as the exhibit is used as a means whereby the farmers will be given practical demonstrations which will help them in improving the stock, grain, roots, or whatever it may be that is exhibited. When these exhibits of farm products are supplemented by an exhibit of women's work, the value and interest is increased.

Additional promising features.—Special sessions of a week's duration; farmers' week; the institute train, especially when the train stops at one place for a whole or half day; domestic science schools of one week's duration; industrial tests among boys and girls; lectures at high schools; good farms competitions; grain institutes; press bureaus—are prominent in the institute work of the past season. It would be unwise to enlarge upon these, as the papers and discussions announced for this convention will deal more or less fully with many of these features.

There is a growing tendency on the part of those who have the direction of the institute work to limit the work of any one session or any one day to some definite topic. It is more profitable to deal exhaustively with some one topic of importance in the locality than to deal in a very superficial manner with several topics.

The value of the successful practical farmer as an institute worker is fully appreciated by the majority of superintendents. They are coming more and more to realize the fact, however, that the practical farmer must not rely solely upon practical experience in institute work. He must be a student and observer, and must have at hand the results of agricultural practice and investigation upon those subjects for which he is announced. The combination of the practical and the scientific will make for the greatest success in institute work.

An increased appreciation is shown by superintendents of institutes and practical farmers of the services of experiment station and agricultural college men. So far as these men can spare time from their college and station duties to attend meetings of farmers or to visit farms and farmers, it is well for them to do so, not only that they may impart information of value to the practical farmer, but that they themselves may become more familiar with the needs of the farm and view the work of the college and the station from the standpoint of the practical farmer. Might it not be well for the college and station men to so arrange their classes and experimental work that they will have more time for observation and consultation work?

There is a growing tendency to bring the institute and the college and experiment station into closer union. In a great many cases the officials of the college or the station direct the work of the institute. However this may be done, the superintendent of the institutes should keep himself well posted as to the work of the college and the experiment station; and this work should, so far as possible, form a basis for instruction work throughout the institutes. The work of the college and the station should be applied through the institute to the varying conditions found in the institute work of the state or province concerned.

(Signed) GEO. A. PUTNAM,
J. D. TINSLEY,
J. H. CONNELL,
Committee.

DISCUSSION.

Franklin Dye, of New Jersey, emphasized the need of agricultural education, especially that looking to the building up of the exhausted soils. He stated that an increase of 50 per cent in agricultural returns had thus been gained in New Jersey during the past nine years. The benefits to be derived by enlisting the support of the preachers and ministers was also brought out.

G. A. Cole, of Arkansas, described the organization and methods of work in his State, and reported having farmers' educational and cooperative unions in 73 of the 75 coun-

ties in the State. The need of holding institutes in the country away from the railroads was emphasized.

R. A. Pearson, of New York, briefly described the method of apportioning institutes in New York.

G. A. Putnam, of Ontario, and Val Keyser, of Nebraska, emphasized the necessity of conducting farmers' institutes through local organizations.

Andrew Elliott, of Ontario, brought out the need of farmers helping themselves.

A. W. Stewart, of Florida, and W. L. Amoss, of Maryland, outlined the methods of work in their States.

Solomon Johnson, of Ohio, indorsed holding meetings for men and women jointly in small towns.

D. P. Witter, of New York, and F. S. Cooley, of Montana, remarked on the close relation between the farmer and the business man of the village, and the need of cooperation between them in institute enterprise.

Mr. Hamilton emphasized the need of thorough and definite organization for all lines of institute work.

On motion the association took a recess until 8 p. m.

Evening Session, Monday, August 16, 1909.

The convention was called to order at 8 p. m., and reports of the standing committees were continued. In the absence of the chairman, T. A. Hoverstad, Fargo, N. Dak., read the following report:

REPORT OF COMMITTEE ON INSTITUTE LECTURERS.

Your committee submits the following recommendations:

(1) That only those be employed as lecturers whose character and personality are such as to command the respect of the audience.

(2) That for the general institute lecturers both scientific knowledge and practical experience shall be required, and that they be familiar with local conditions and requirements.

(3) That special lecturers be only those of exceptional ability or having a special message on a certain subject.

(4) That lecturers be paid for their services at least equivalent to what is paid in colleges and universities for work requiring talent and training of the same order, and that their employment be made more permanent, so as to justify persons in preparing for this class of work.

(5) It is recognized that institute work is strictly educational in character. It is recommended that institute lecturers make distinct the line of demarcation between the institute and political institutions.

That lecturers should have character that commands the respect of the audiences will not need discussion. There are lecturers that have been employed whose standing in the neighborhood has not been of the highest order. Persons whose main object is to sell some commodity or pave the way to some political office should not be given the institute platform. Skill in covering up such object should be regarded as an objectionable characteristic in the institute lecturer.

In recommending that institute lecturers shall be in possession of scientific knowledge and practical experience it does not mean that they necessarily must have a college degree. Neither is it absolutely necessary that they shall ever have been students in a college. The committee is conscious of the fact that some of the very best institute workers have been those who have not had college training. Neither is it absolutely necessary that a man shall be a farmer during the time he is doing institute work. In case the institute lecturers have these requirements it matters not where such experience or knowledge has been gained. It is believed, however, that the future institute men will be those who have had a college training and have learned from practical experience on the farm the best methods of farming for the locality where the institute is held. This should be supplemented by constant study and close observation. Conditions vary in different localities. Those who have been doing institute work are familiar with the fact that while two institutes may be held only a few miles apart the suggestions on methods of farming in one need to be very different from those in the other in order to be in harmony with local demands. It is also found that in the same place conditions may be very different one year from

what it is in the succeeding. One who is a stranger to the changes in local conditions can not be as useful as one who is thoroughly familiar with them. The institute lecturer, to be a success, must be very sensitive to the change in environments so as to adjust himself to these conditions. He should also be sensitive to the condition of the audience during the time he is speaking, and so adjust his talk to secure their confidence. A successful institute lecturer does not always have inflexible views. He may have certain principles that he adheres to with great tenacity, but he is always willing to modify the little details to be in harmony with local demands.

Special lecturers will be more in demand in the future than they have been in the past. These will be largely employed because they have given special study to one branch of farming. At times it may be wise to secure a lecturer of acknowledged ability even if his special subject is not strictly agricultural.

It is important, in order to be a successful institute lecturer, that a man have peculiar natural talent as well as long training. His work is always before the public. He is subject to the closest criticism at all times. A man to be a successful institute speaker for a period of years must have many special qualifications. In the past it has frequently been found that when a person has been in the institute field until he is known to be a success, colleges, stations, or private individuals offer him remuneration that induces him to leave the institute field for other employment more remunerative and often more pleasant. This is unfortunate and the institute has suffered seriously from this source. It is believed that the institute lecturer requires ability of the highest order and in order to attract men of this type wages should be paid sufficient to induce them to enter and remain in the field. In very many cases it may be a wise plan to pay a higher price than the institute lecturers now employed are really worth. If high wages are paid talent is going to seek the prize. The lecturer's employment should also be made more permanent. To be employed only for a few weeks of the year and then to leave the institute field for other employment is unsatisfactory. It would be wise to try to raise the character of the institute work to as high a plane as possible. It is believed that the institute is one of the most important educational fields of to-day, and it is to be hoped that men of ability and talent will be secured to help make it an institution commanding the highest respect.

Respectfully submitted.

E. R. Lloyd,
T. A. Hoverstad,
B. Walker McKeen,
Committee.

K. L. Butterfield, of Amherst, Mass., chairman of the committee, read the following report:

REPORT OF COMMITTEE ON COOPERATION WITH OTHER EDUCATIONAL AGENCIES.

Your committee desires to present a report dealing briefly with the special subject of cooperation with other agencies engaged in disseminating agricultural information, or in popularizing agricultural education, confining the discussion to those agencies which are supported chiefly by the state.

As a practical matter this subject will resolve itself into two questions; first, that of utilizing farmers' institutes in some general system of agricultural college extension, and second, cooperation between a system of farmers' institutes managed by the state board of agriculture, or some semipublic agency, on the one hand, and on the other hand the agricultural college, which presumably is doing more or less extension work. The distinction just made is of considerable importance to the future of farmers' institute work. We must think of the farmers' institute both as a particular method or mode of reaching the people and as a general system of educational endeavor.

Cooperation with extension schemes.—Let us first discuss the place which the farmers' institute is likely to fill in the general scheme of agricultural college extension. Roughly speaking, three main lines of work will be carried on by the extension department of an agricultural college:

(1) Formal instruction, more or less thoroughly organized through reading courses, lecture courses, correspondence courses, movable schools, etc.

(2) More or less informal or desultory instruction, carried on through various public meetings or conventions, of which the farmers' institute is one, miscellaneous itinerant lectures, the printing of various kinds of literature, and the development of various object lessons.

(3) The work of organizing or federating different agencies for agricultural advancement is one which may very properly be headed by the extension department of the agricultural college.

Even in this rough outline many forms of organized extension work are to be seen. The farmers' institute is likely to be simply one of many other ways of reaching the farmer. We think it is important that this fact shall be recognized. We are just at the opening of a great era of popular education in agriculture and country life. The institute has rendered noble service, and yet we ought to recognize frankly that a score of other forms of work may be equally as valuable as the farmers' institute.

Having said this much we wish to say with equal emphasis that in our judgment the farmers' institute as it is commonly known and understood will always be one of the most powerful means of reaching the masses of the farmers. We can not conceive of any well-organized system of extension teaching which does not include, or which is not at least allied with, a more or less systematic form of public meeting, and which, whether or not called by the name "farmers' institute," follows in its plan, purpose, and atmosphere the traditional farmers' institute scheme.

It is not the intention of the committee to outline the precise relationship between this particular kind of meeting and the many other devices and plans which extension work will develop in the coming years. But we do say emphatically that the farmers' institute, as we know it, must be recognized in the future as it has been in the past, as a large factor in the development of education in agriculture and country life.

Yet a consideration that must necessarily come to the front in the immediate future in those colleges which have managed farmers' institutes, and which at the same time are developing other forms of extension work, will of course be the relationship between the old institute scheme and the new extension work. Some of this extension work is being managed by departments of agricultural education and by experiment stations, and is developing in all sorts of miscellaneous ways. Eventually this work will be thoroughly systematized under one general management and known definitely as agricultural college extension work; each institution must work out its own problem of cooperation. But cooperation there must be.

Suppose we have a superintendent of farmers' institutes, employed by the agricultural college, whose chief function is to manage a well-developed institute system. Suppose we have alongside of this various forms of extension work gradually developing. In some way or other the administration of the college must secure close and definite cooperation between these different lines of work.

In many cases the superintendent of farmers' institutes may well become the head of the whole extension movement, and out of the present institute system develop a wide extension organization. In other cases it may seem best to reduce the amount of institute work, and to enlarge more rapidly some other lines of work. But whatever is done, there must be a clear understanding within the college and in the public mind of what is going on, and of the necessity of the cooperation to be secured.

Cooperation with agricultural colleges.—In somewhat less than one-third of the States of the Union, farmers' institutes are managed by state boards of agriculture, or by some voluntary associations receiving state aid, and have no organic connection with the agricultural college. In most of these States farmers' institute work developed under this kind of management before agricultural colleges had done very much to popularize agricultural education. The early boards of agriculture regarded it as one of their chief functions to disseminate agricultural information. Where this form of management exists it is clear that the cooperation needed is largely between the farmers' institute system and the agricultural college itself. As a matter of fact, there is already a great deal of this cooperation—in many States close cooperation—and very little friction develops. The agricultural colleges furnish a good many lecturers for farmers' institutes, and the information collected by the colleges is always at the disposal of the farmers' institute workers. Your committee believes that even closer cooperation, however, should be brought about by mutual agreement as to special phases of work that will be developed through the farmers' institute system and those which will be chiefly cared for by the agricultural college through its extension-work department. In general, it would seem to be wise policy that the farmers' institute system should avoid what we have called formal instruction. Doubtless there is other work that in the nature of things can also best be done directly by the college and by the college men. On the other hand, the board of agriculture can well be the leader in certain movements that need the helping hand of the State for general direction and leadership.

The final place of the farmers' institutes and of the institute system.—In concluding this part of the report let us repeat that the farmers' institute, as a kind of meeting, a type of work, has in our opinion a permanent place in any adequate system of agricultural education, no matter whether it is carried on directly by the agricultural college or by the state board of agriculture, or similar agency. This is true because of the very nature of the farmers' institute. It is a public meeting in which the farmers themselves participate. The speakers are men who are themselves successful farmers, or who are in extremely close touch with successful farmers. There is ample room for discussion;

there is a variety of topics; there is interest, and there is enthusiasm. There is the advantage of face-to-face work, the power of the spoken word. The institute is an event to a community if it is properly managed. It is thoroughly reported in the newspapers; it draws a good crowd. It "stirs things up" and ought to furnish, and usually does furnish, inspiration. The farmers' institute, or something very much like it, therefore, can not be dispensed with. On the other hand, a system of farmers' institutes is really a matter of convenience and wisdom. Some States have developed a very thoroughgoing, systematic plan to carry on farmers' institutes under the auspices of the agricultural college; other States have developed the work in a comparatively unorganized fashion; still other States have developed a farmers' institute system through the board of agriculture. The present status, therefore, of farmers' institute systems is largely historic. That is to say, they have developed out of the conditions peculiar to the different States. There is no inherent reason why any logical system or form of management is better than another, or why it should persist indefinitely.

Responsibility for different kinds of work.—Your committee does not propose to prophesy that the tide of affairs will gradually bring all farmers' institute work into the hands of the agricultural colleges; nor do we propose to lay down the proposition that we think that is what ought to be done. It seems to us that this is a minor matter. In some States this is surely going to be the result; in other States it will take a long time for it to come about, even if it ever does, and undoubtedly in some States it is wholly undesirable that it should come about. As we have just said, we regard this as wholly a minor matter. There is, however, in our judgment, a thoroughly fundamental consideration not to be overlooked in this work of cooperation between farmers' institute systems and the agricultural college. In order to make this clear, your committee lays down the following general propositions:

(1) The college is primarily an educational institution. Its design is to serve as an organ of knowledge. Its task, therefore, is to discover new truths, and to disseminate known truths. It discovers new knowledge and makes new applications of knowledge through the experiment station. It disseminates knowledge partly through its means of reaching students who come to it for a residence of a greater or shorter term, and partly by sowing broadcast among the people at large those grains of truth that promise most for the development of a good harvest of agricultural progress.

(2) It therefore becomes the function of the college to teach farmers, as well as to teach the students who come to college. The college could not ignore this function if it wanted to. It must do this as a matter of debt to the constituency which supports it. It must do this as a matter of public demand. It is even a question of self-protection.

(3) Indeed, the agricultural college, simply because it is an educational institution, because it is organized to do educational work, and is officered by men whose interest presumably is in educational purposes, will in the long run be more efficient than any other public agency in developing popular forms of education. The fact that other agencies have perhaps been more powerful does not at the present time afford, in our judgment, a forecast for the future. All this is not to say that there may not be a multitude of means of disseminating agricultural information, or of reaching the rural people, other than those of the agricultural college. The greater the work of the agricultural college along this line the greater the scope and efficiency of these other agencies and associations. But an efficient agricultural college must necessarily be the most efficient organ of popular agricultural education, at least in so far as thoroughly organized, systematic instruction is concerned.

(4) As legislation increases, as farmers come to demand more protection, there will develop an increasing need for what may be called control, or police work on the part of the State. We already have a good deal of this sort of legislation, and various boards and commissions are designated by the State to enforce these rules. The State is also inclined to head large movements for the development of the agricultural industry. So we find an increasing need for some thoroughly organized public agency which shall cover the ground just referred to. It seems to your committee that this type of work is not the type that ought to be done by the agricultural college, but that it is primarily the work of a state department of agriculture, or of a state board of agriculture. It would seem clear, therefore, that the highest form of cooperation between the different institutions interested in farmers' institute work will be the development of the educational work chiefly by the college, and the public service and police work by the state department of agriculture.

Respectfully submitted.

KENYON L. BUTTERFIELD,
GEO. MCKERROW,
GEO. C. CREELMAN,
Committee.

DISCUSSION.

E. E. Elliott, of Idaho, spoke of the importance of home-life education as a fundamental agency, and also emphasized the need of education in building up the soil.

In the absence of the chairman, L. R. Taft read the following report:

REPORT OF COMMITTEE ON MOVABLE SCHOOLS OF AGRICULTURE.

The various reports of the standing committee on movable schools of agriculture, as presented at the annual meetings of this association during the last four years, have dealt with the needs, objects, and development of this branch of agricultural extension work in the United States and Canada in a very thorough manner. The secretary of the association, if he did not first suggest it, was the first to bring this work to the attention of the association. After looking into the methods employed in European countries in 1905, he presented a paper on movable schools of agriculture which brought it to the general notice of all interested in the extension of agricultural knowledge on this continent. Long institutes, short courses, traveling dairies, and seed, alfalfa, and corn trains had paved the way for and made a stepping-stone from the regular institute to the more thorough, systematic, and advanced step—the movable school of agriculture. The Department of Agriculture has undertaken to prepare courses of study for this purpose, and has already issued bulletins giving courses in cheese making, fruit growing, and cereal foods for these schools.

In 1906 this matter was further dealt with by an able committee, and on their recommendation the association passed a resolution approving of the use of such schools and commending the form of organization outlined and courses of study prepared by the Department of Agriculture. The result was that many States and Provinces accepted the advice and, as far as the organization in each would permit, attempted to put into practice the principle of this work.

We have no accurate record of the advancement made in 1907, but the report for 1908 shows that the work of Mr. Hamilton in 1905, and the advice of the standing committee in 1906, bore good fruit. The courses of study and specific form of organization recommended were not generally accepted, but the principle of the movable school movement was put into practice in many different forms and under many different names. At the time of the annual meeting in Washington nine months ago, ten States had taken up the work, and in a more or less modified form five Provinces and ten other States were taking it up. This is in brief a statement of the growth of the movable shool movement up to the present time.

The thoroughness with which the status of the movement was placed before you a year ago rendered it inadvisable that this feature be touched upon this year. Your committee have, therefore, confined themselves to a brief and very general consideration of the work as it is developing in the country to-day.

Movable schools of agriculture, as such, exist in but a few States and Provinces. Under various other names they are doing good work in nearly every section of North America. Institutions known as long institutes, short courses in stock judging, seed judging, fruit growing, cheese making, butter making, domestic science, poultry raising, and grain production; seed specials; alfalfa specials; corn specials; farmers' institute schools, and many others are carrying advanced instruction to the rural population in all branches of agriculture as surely, if not as thoroughly, as the movable schools. Thorough and advanced agricultural instruction for the maximum number of that class of the community that has, as it were, graduated from the regular institute, is the aim of the movement, and it is not necessary that it be known as a movable school if these results are attained under some other name. We, however, commend the movable school as at first launched as being the best in principle, and we recommend all institute workers and agricultural extension superintendents to develop their present organization in such a way that this work may, if not immediately, at least in the near future, be taken up in conjunction with it.

The most popular form this movement has taken is known as the "Short courses in agriculture," which are put on at different places in different States. Iowa and Colorado probably show the greatest development in this direction. The farmers' institute schools or short courses in Nebraska are closely related to this movement, and the work of the movable schools in Maryland, Pennsylvania, and Alberta, and that in the county agricultural schools of Wisconsin is achieving practically the same results under somewhat similar management.

Specialization in subject matter, thoroughness of teaching plan, and careful combination of principle and practice, applied in as many cases, and reaching the largest possible number of rural people, should be the aim of the institute or extension department. If we are to be worthy of our trust, we must reach more people than the agricultural college does at present, and we must give them more thorough and

definite information than the old-time institute. To do this, the movable school of agriculture has come to our aid.

When instituting this work several things should be taken into consideration—

The extent of territory in charge.—A small State with an agricultural college near its center and good transportation facilities has less use for movable schools than a larger one, especially where transporation facilities are poor. When an agricultural college can be reached at a minimum cost it is well that every opportunity and encouragement be given students to take short courses at such institutions before it is decided to conduct movable schools a short distance away.

Advancement in agricultural knowledge on the part of the people to be served.—A new district containing a population which does not appreciate thoroughly its own condition with regard to the line of agriculture to be followed can probably be served best for a short time by the regular institute or the long institute where practical men give their experience on agricultural questions, and where the intensely practical side of the work receives more attention than the "why" of the methods used. On the other hand, in constituencies where farmers' institutes have been in vogue for some time the leading farmers have imbibed a large share of the information the institutes have to give, and if progress is to be made something must be done to give them more advanced and scientific information. It is just here the movable school fits in. It takes the more practical part of the agricultural college work together with enough science to make it understood and interesting to the man on the soil who can not go to college and who for possibly legitimate reasons will not attend the regular institute.

The percentage of the population now being reached by the present system.—Every director of extension work has a fair idea of the percentage of men engaged in agriculture who are reached and influenced under the present system of instruction in his State or Province. General experience teaches that the attendance at farmers' institute meetings is but a small percentage of what it should be. Where such is the case and where no organization similar to the movable school exists your committee strongly advises its introduction. The institute directors and extension superintendents will find that it not only does most valuable work in the districts where it is held, but it incites the whole population to a deeper regard for and a keener appreciation of the value of an agricultural education. This is an indirect result but one that should not be overlooked.

Coordination with or fitting into other work.—Many States have very thoroughly organized extension departments in which it would be difficult to insert movable schools. Where county agricultural high schools exist, where short courses are held in different parts, or where the organization takes thorough information on the lines of agriculture being followed to all parts of the State, the movable school is not so necessary and could not so well be made to fit into the other work. Where a complete organization of this kind does not exist, your committee suggests that the directors interest themselves in the holding of movable schools. We feel that these will assist the farming community by giving its individual members the opportunity of getting at first hand thorough, reliable, and complete instruction in the work they are following.

Securing the staff.—The men who do the lecturing and demonstration work should be taken very largely from the agricultural college, experiment station, board or department of agriculture. It is hardly necessary that your committee impress upon the directors the desirability of having thoroughly capable demonstrators and lecturers on all subjects taken up.

Cost.—From investigations made your committee believes that the cost of demonstration apparatus and the salary of speakers and demonstrators should be borne by the State, while the board and traveling expenses of speakers, rent of building, and all other expenses should be met by the district or organization in charge. It would be idle to quote figures here since the different classes held will require such vastly different apparatus and demonstration material that approximate costs would convey little meaning. A close estimate can, however, be prepared by those in charge and provision made to meet all probable liabilities. In Iowa, corn shows have been held at the time of the courses and the proceeds from the sale of the prize corn, together with that from advertising, entries, and membership fees completely covered all expenses.

In closing, your committee indorses the whole principle of the movable-school movement as being one that will at a minimum cost carry to a great number of people a systematic, thorough, and definite knowledge concerning the different branches of agriculture followed in the sections of the continent where it is taken up.

Respectfully submitted.

John Bracken,
Alva Agee,
L. R. Taft,
Committee.

DISCUSSION.

L. R. Taft, of Michigan, remarked that each State should be its own judge as regards its movable-school needs. Farmers who have outgrown or graduated, so to speak, from ordinary institutes should find the movable school profitable. A small fee should be charged.

Val Keyser, of Nebraska, described the movable schools in his State where they have proven to be a great success. They require twenty-five signers at $10 each in order to establish a school, and the instructors in the agricultural college are largely used in these movable schools. The college furnished charts and the like, and the community furnished building, furniture, and materials used in demonstration.

E. A. Burnett, of Nebraska, brought out the need of pioneer work and ordinary institute work in order to pave the way for movable schools.

J. H. Worst, of North Dakota, remarked on the growing demand in the Northwest for movable schools, and called attention to the practice in Holland of having a director for each Province, to whom the farmers go for advice and assistance.

G. A. Putnam, of Ontario, stated that they had conducted movable schools in places where the regular institutes were a failure, and the result was excellent schools, followed by renewed interest in the regular institutes; and he regarded the movable schools as meeting with greater success than any other work.

E. E. Kaufman, of California, called attention to the difficulty of obtaining suitable instructors for movable schools.

R. A. Pearson, of New York, gave a brief outline of the movable-school work in his State.

W. C. Latta, of Indiana, spoke of the qualifications of the members of the college faculty as making the best instructors for movable schools, where some scientific as well as practical knowledge is essential.

Val Keyser, Lincoln, Nebr., chairman, read the following report:

REPORT OF COMMITTEE ON BOYS' AND GIRLS' INSTITUTES.

In answer to a list of questions sent to all the States and Provinces active in this association, forty replies were received. Of this number, twenty-four reported that no boys' and girls' institutes or meetings of this kind had been held as yet, though quite a number of the States expressed their appreciation of work in agriculture and domestic science for the young people.

Sixteen States have organizations conducting work for the boys and girls along institute lines, but very few of these organizations are designated as boys' and girls' institutes.

Arkansas.—Arkansas has organized boys' and girls' clubs to be conducted by the department of agricultural education. No specific appropriation is made, but the work is aided by the contingent funds of the college of agriculture, University of Arkansas. The boys' corn clubs are local affairs handled by the counties. Boys are expected to exhibit at county, state, and national fairs. The college will send out judges. Age limit of contestants, 20 years. C. F. Adams, dean and director.

Florida.—Florida has no separate organizations for boys and girls as institutes. The farmers' institute speakers have from time to time addressed the boys and girls of the public schools, either in the school houses or at separate meetings at the farmers' institutes. P. H. Rolfs, director.

Illinois.—The greater part of the work with boys and girls is done through the county superintendents of schools. We make no attempt to direct the work, but encourage it in every way possible. In some counties the work is effective and valuable. It results in carrying instruction in agriculture and domestic science into the common schools, which is the aim. Contests are held in connection with regular farmers' institutes. The state department cooperates with the school system, which has local organizations in some counties, and holds county contests, but no state show or state meeting. The institute lecturers sometimes address meetings, giving instruction in corn judging. No money is appropriated for this work, but it is carried on in connection with county institutes. Frank H. Hall, superintendent farmers' institutes.

Indiana.—Indiana holds boys' and girls' institutes as part of the farmers' institutes. The county chairman of institutes and the county superintendents usually cooperate in organizing these clubs. The state superintendent only suggests and advises. Contests in the growing and exhibiting of corn and in making and judging bread and butter are held by the counties, but no state meeting. The State has fifteen clubs and forty contests. Fourteen sessions of the regular farmers' institutes were also reported. Speakers and judges are sent whenever practicable, and their talks have direct relation to the work of the clubs. No state appropriation is made, but the work is financed by county farmers' institute associations. One county appropriated $1,000. Excellent interest is manifested and fine exhibits are shown at contests. An effort is made to hold school clubs with school districts officered by members, but supervised by teachers, holding meetings at definite times. W. C. Latta, superintendent of farmers' institutes.

Kansas.—Kansas has held no special institutes for boys and girls, but quite often a session of the regular farmers' institute is given over to the boys and girls. Contests for the boys and girls in agriculture and domestic science are conducted. Boys and girls are divided into two classes according to age: Class A, 15–21 inclusive; Class B, 10–14 inclusive. The superintendent of farmers' institutes and agricultural extension of the college of agriculture expects to have a man whose special duties are to look after the work of the boys in agriculture, and a woman to have charge of the work of the girls in domestic science. J. H. Miller, superintendent of farmers' institutes.

Michigan.—In about a dozen counties contests for boys and girls were carried on. The arrangements for this work were all looked after by the farmers' institute association and county commissioner of schools. Prizes for the best ten ears of corn or peck of potatoes and for samples of bread, butter, and sewing were offered. Arrangements have been made in a number of counties to have preliminary meetings of the boys who are to enter the contest at which special instruction in corn culture is given. The exhibition of the products is shown in connection with the county institutes and the best samples are then shown at the state round-up institutes, where special prizes for corn are offered by the State Corn Improvers' Association. While no special institutes for boys and girls have been held, at fully one hundred of the farmers' institutes the schools have been dismissed and the program for the afternoon and evening sessions was arranged to be of special interest to the boys and girls. At these meetings a special speaker, furnished by the commissioner of schools, was present and took part in the program. At still other institutes, classes from the high schools and from the county normal schools were in attendance and were expected to furnish a write up of the papers presented as a literary exercise. The topics related to agriculture, domestic science, and the home. No special appropriation has been made for this work, all expenses being paid out of general institute funds, except local expenses and prizes, which are looked after by the county institute societies. L. R. Taft, superintendent of farmers' institutes.

Minnesota.—The main work done along this line has been through boys' and girls' contests. The meetings held in connection with this work are called special seed institutes. The contests are under the supervision of the county superintendents in different counties. Last year thirty-one counties were active in the work; forty-four counties are now carrying on this work. One man is employed by the department of farmers' institutes for three months of the year to go from county to county with the county superintendent to visit schools and talk of the work to be undertaken. He also addresses gatherings of school-teachers and school officers' meetings. No money is appropriated for this work. Prizes for contests come from private subscriptions. Other work is paid for from farmers' institute fund. The judges usually speak on subjects pertaining to exhibits at state contests and general agricultural education. The age limit of contestants is usually 18. A. D. Wilson, superintendent of farmers' institutes.

Mississippi.—In Mississippi the work is financed by the department of farmers' institutes. Various names are applied to these boys' and girls' organizations. The age limit for contestants is from 10 to 21. The department of farmers' institutes furnishes speakers and judges. Thirty-two counties have boys' corn clubs and a few have girls' domestic science clubs. The aggregate membership of these clubs is, at present, about 6,000. The girls' clubs have a membership of about 1,000. This work is under the supervision of the county superintendents, who call upon the college faculty for judges and lecturers at the contests. The best exhibits from county contests are taken to the state fair. In some of this work in one county, having a boys' corn-growing club of 300 members, the largest yield per acre last year was 124 bushels and the average of the 300 boys was 70 per acre. The last legislature passed a law establishing county agricultural high schools. Ten counties have taken advantage of this privi-

lege. The institute department visits these schools and helps to work out a curriculum for them and holds a short course in agriculture from three to six days at each school during the year. E. R. Lloyd, superintendent of farmers' institutes.

Nebraska.—In Nebraska boys' and girls' institutes have been conducted, beginning with the season 1905–6. This work is more commonly called "boys' and girls' county contests in agriculture and domestic science." The work is supervised jointly by the state department of public instruction and the University of Nebraska through the department of farmers' institutes. The county superintendents are, as a rule, county managers and work largely through the teachers of the rural schools, although the schools in towns are allowed to participate. Bulletins to aid the boys and girls in the work are furnished in editions of from 10,000 to 15,000. Thirty-three contests were held during the past season, to which speakers and judges were sent from the university. The total number of boys and girls attending these contests was 9,266. At several of the contests there was such a large number of exhibits that it was necessary to send two men and two women in order to finish the judging in one day. During the present year the boys are carrying on some experiments with corn such as: The ear to the row test; soil fertility and rate of planting. The girls will exhibit their work in cutting and fitting aprons and shirtwaists. A short course in agriculture and domestic science, lasting for one week, is offered by the school of agriculture to delegates from each county holding a contest, during the week of the state meetings of organized agriculture. Fifty counties are carrying on the work this season. The state board of agriculture and state corn improvers' association are contributing to the support of this work and a special judging contest is arranged for boys at the state fair. Val Keyser, superintendent of farmers' institutes.

New York.—New York has held a large number of meetings for boys and girls in agriculture and domestic science. This work has been conducted by the state department of agriculture and the state college of agriculture at Cornell University. They also cooperate with the state department of education, which department furnishes one speaker to go with each institute corps. Principals of schools and school teachers are notified in advance when the institutes will be held in their localities. The representative from the state department of education and one or two of the institute speakers go to the school for the purpose of giving talks to the children. These addresses are often given before the school children while the institute is being conducted in another building. We have no figures at hand of money used in this work. The fact is that we are getting large results from very small expenditures. We believe strongly in work with and for the children and we have four or five excellent speakers who discuss agriculture from the standpoint of the young people. R. A. Pearson, commissioner of agriculture.

North Dakota.—This work in North Dakota is called agricultural contests for boys and girls. It is conducted under the direction of the state department of agriculture, which cooperates with the school system. County superintendents supervise county organizations. The nature of the work is agriculture with a little domestic science and domestic art. No state meetings are held, but speakers are sent from the college of agriculture to aid the local meetings. They talk corn possibilities, varieties adapted to conditions, and cultural methods; also take up questions of poultry and potato growing. The railroads furnish transportation. Other expenses are borne by local superintendents. The benefits of this work are that the young people are receiving facts worth knowing and a higher appreciation of farming as a vocation. T. A. Hoverstad, superintendent farmers' institutes.

Oklahoma.—The school of agriculture is organizing the Oklahoma boys' and girls' agricultural club. The plan is to organize local clubs wherever possible, and teachers, county superintendents, farmers' institute officers, and women's auxiliary societies are invited to cooperate in forming these clubs and to send the names of all boys and girls interested to the school of agriculture, Stillwater, Okla., and to arrange for a competitive exhibit in each county in connection with the next farmers' institute. County superintendents take this matter up with the institute officers and announcements are made as early as possible of the classes for which premiums will be given. It is suggested that separate classes be arranged for boys and girls of school age and for adults. The prizes cover all the common farm crops and as many varieties of each as the funds will permit; also such household products as needlework, bread, pastries, canned fruit, and butter. The college will, from time to time, send the boys and girls instruction upon the various lines of work in which they may be interested. It is hoped that this movement will arouse such interest on the part of the boys and girls and make them so skillful in their common work as to raise it from the realm of drudgery. H. P. Miller, superintendent.

Ontario.—We have not in Ontario what can be called "boys' and girls' institutes." Some of the institutes have held special judging classes for boys and have, in a few instances, given small prizes to those who have shown the greatest ability in judging live stock and grain. At some of the women's institutes—of which we have 525 to 530—they have taken up work of special interest to girls. The younger daughters of members bring samples of cooking, canned fruit, and other articles prepared in the home, for exhibition at the institutes. Small prizes are awarded or recognition given in some other way to the girls showing greatest ability in preparing exhibits, also in explaining how the dishes or articles were prepared. We have district representatives in eleven counties of the Province, and some of these have done some work with the school children. For instance, in one county samples of various kinds of seeds—potatoes, turnips, mangels, etc., are distributed among the scholars of three schools. The pupils plant these in a certain way and follow directions in caring for and harvesting the same. The scholars accepting seeds are required to exhibit the produce at a fall fair held at the central school. This is creating great interest and will, no doubt, result in much benefit to those who participate. The work of the district representative is under the joint control of the department of education and the department of agriculture. George A. Putnam, superintendent of farmers' institutes.

Pennsylvania.—This State has no separate department for boys' and girls' institutes, but many county superintendents and teachers cooperate and bring classes to the farmers' institutes, where a separate session is devoted to topics for them. Many counties have corn and poultry exhibits which give good results. Speakers and judges pass upon the merits of exhibits in competition. A. L. Martin, superintendent.

South Dakota.—South Dakota has held but one boys' and girls' institute to which special lecturers were sent. The meeting lasted four days, with an examination on the fifth day, at which local people donated prizes. Regular class instruction in stock and corn judging was given for the boys. The girls had separate lecturers between the women's meetings, at which the subjects of needlework, care of the body, and home hygiene were taken up. The girls also attended the women's meetings when culinary demonstrations were given. These meetings demonstrated the importance of boys' and girls' institutes, but there have been no available funds to conduct them. Several boys' corn shows are held in connection with farmers' institutes, in which cases judges were furnished by the state department of farmers' institutes. About fifteen counties have organizations for conducting boys' and girls' contests. Expenses are raised by local subscriptions. The age limit is based upon whether or not the pupil is attending school. Where these contests are held, more interest is taken on the part of the young people in institute work, and it seems to dignify the profession of agriculture in the minds of the boys and girls. A. E. Chamberlain, superintendent farmers' institutes.

Washington.—The State of Washington has taken up this work through the college of agriculture and the Oregon Railway and Navigation Company. A number of demonstrations are conducted in corn counties and prizes are offered for the best yield of corn on one-fourth acre. The prizes run as follows: First, $40; second, $30; third, $20; fourth, $10; and for best ten ears selected from competing tract, first, $5; second, $3; third, $2. There are 536 boys enrolled in this contest. They were addressed in a separate coach on the train and received printed instructions. The work is not held in connection with regular farmers' institutes. R. W. Thatcher, director of station.

In compiling this report, the committee has considered it a privilege to mention the different organizations which have for their object the promotion of work along the lines of agriculture and domestic science for the young people. It is interesting to note the increasing interest which the various States are taking in this work for boys and girls. In the report of the 1907 meeting of the association only six States had undertaken work of this character. Not quite two years have passed, and to-day we have reports from fifteen States that are conducting some form of boys' and girls' institutes, and many of the superintendents from other States realize the importance of this movement, and are only hindered from undertaking the work by lack of funds. In many respects the institutes for boys and girls have a decided advantage over meetings of this sort conducted for the benefit of adults. Where boys' and girls' organizations are managed by officers connected with the public school system, and the membership consists largely of children of school age, an effective method of getting information to the members is afforded. Where contests are held, a direct means of measuring the good accomplished is established, as the boys and girls bring the perfected product of their work in the form of exhibits to be shown at the contest. On the other hand, we are working with these little men and little women at the period when the formation of the right habits and right ideas of industry is most im-

portant. These boys and girls are at the age when their enthusiasm runs highest. Their interests and activities are directed in channels which will sharpen their insight and increase their appreciation of the importance of their daily duties on the farm and in the home. The ultimate object of undertaking this work, as expressed by many of our superintendents, is the introduction of the study of agriculture into the curriculum of the common schools. The committee believes that when this object is accomplished there will still be room for boys' and girls' institutes and organizations of this character, especially if the contest is made one of the chief features of the work.

The competitive idea is likely to continue throughout the existence of humanity. In nature's scheme of generous planting, species in the vegetable world vie with one another for existence. This principle is equally true in the animal kingdom. The great state fairs are maintained largely because of the opportunity they offer for men to exhibit their handiwork in competition. This system has become a great educational factor in improving the animals and crops produced upon the farm. The contests for boys and girls are no less important than the local fairs of our States, and when held in connection with an institute or a meeting which affords an opportunity for the exchanging of ideas concerned in the production of these material things, much good is sure to result. Your committee heartily indorses the plan of having these boys and girls work with useful things and practical problems, such as the improvement of corn and other cereals; the making of bread, butter, and articles of wearing apparel, which have so interested the young people.

We recommend that, wherever possible, the state college or department fostering this work try to cooperate with the public school system.

We have asked Mr. E. C. Bishop, the superintendent of public instruction in Nebraska, who was one of the original promoters of this work, to prepare the brief article which follows.

Mr. Bishop says:

"The work of the Nebraska boys' and girls' clubs is an outgrowth of the idea that all education is not obtained from books; that the ordinary routine affairs of the home, if properly administered, may become not only educative in a high degree, but enjoyable and uplifting. The long-continued cry against the ineffectiveness of the public schools comes from the feeling that there is not felt in the homes that degree of interest, skill, and enjoyment which should exist in those things which demand the attention and service of the young people who must live in the home and are educated for that purpose in school.

"Education which unfits the youth for the home life is wrong education; education which encourages the formation of undesirable mental, moral, or physical habits is bad education, education which within itself is good but which draws the youth away from essential elements which are necessary to the best development of citizenship is careless, misdirected education. A State can not afford to spend the funds of the people for wrong education, bad education, or careless, misdirected education.

"Since the introduction of modern machinery on the farm and labor-saving devices in the home, the tendency is a general relaxation of the earlier educative home practices which train the child to become skilled in the industrial arts concerned in the maintenance of the home. The result is now being felt in the lessened interests of the child in the affairs of home life. The lack of interest and skill in performing the ordinary yet necessary tasks about the home has naturally developed a desire in the child to seek elsewhere than the home for the satisfaction of his right ambition. The school has gradually taken to itself the neglected duties of the home. Courses of study are now including such of the industrial work as can be provided and handled in the school. Where provision can be made, instruction in domestic science and manual training is introduced.

"But the schools that can and do provide such training are far too few. We must have a connecting link between the school and the home which will encourage the child to make use of the knowledge, inspiration, and ideals presented there, by carrying to the home the desire to know more about the things which concern his everyday life, and to acquire a reasonable degree of skill in the performance of such duties.

"When the child learns to make all his work educative by doing it the very best way it can be done, then his work becomes attractive, and his home is the center of his interest, activity, and enjoyment.

"It is for this purpose that boys' and girls' clubs have been organized in Nebraska schools. The aim is through the teacher to cause the boy to become interested in the work of the farm or the activities of the community in which he lives, and to cause the girl to become interested in the work of the home in preparing food and wearing apparel, and household decoration and furnishings, to cultivate a love of flowers, an interest in plant and animal life, and all that goes to make up the items of interest in the home life.

"The best way to awaken a proper degree of interest in any good work is to cause the child to do that work with his own hands, to study it as he works, to learn the why, the when, and the how, of all processes concerned, and to do everything attempted the best way it can be done, with the least expenditure of time, labor, and effort.

"Boys' and girls' clubs ask the individual members to learn how to do well some particular thing connected with the home life. By showing the results of his labor, by discussing plans of procedure with others, each will gain a new interest and new ideas, which will make him a thoughtful student in all that he does both in the schoolroom and in the home."

Respectfully submitted.

Val Keyser,
A. E. Chamberlain,
F. H. Rankin,
Committee.

In the absence of the chairman, the secretary of the association read the following report:

REPORT OF COMMITTEE ON WOMEN'S INSTITUTES.

Owing to the fact that other members of the committee have failed to report, I can speak of the work only from my own standpoint.

So far as it is possible to have it, the work of women's institutes wherever entered upon has been for the welfare of the home and community. The women interested in this work find value from three standpoints—to the individual, the family, and society. The individual finds educational help—the getting of knowledge by trying to convey knowledge to others and the spreading of practical learning through the experiences given by different members. The family profit is that through these discussions the home maker is induced to bring a greater element of science into the art of home making, and less is left to chance. With a knowledge of the laws of domestic science there must come into the home greater health, prosperity, and happiness. And every well-governed home is a benefit to society, an influence for good, and a protection against evil, not only to the members of the individual household, but to society at large.

The element of danger in institute work is in being too superficial, taking up too many subjects during one season's work, and not having a thorough mastery of any. A delegate who is more anxious to entertain than to teach has really no message for those women who live on farms, "far from the madding crowd;" no understanding and sympathy with the lives which must find delight in nature, and pleasure in the work at hand; no power to fire these lives with ambition for a higher standard of life in all its phases.

The need of countrywomen is to have drudgery taken from their work by placing in that work the leaven of system and science, and with that system there should be the knowledge of the importance of home work; the influence of foods upon mind as well as body; the influence of thoughts, of words, of happiness; the influence of the air we breathe, the water we drink, the sights which surround us. In fact women should know and feel that home is the real school, and the women in the homes the teachers of the nation. Therefore institute work should be educational, a spreading of the knowledge of those great sociological factors which control the conditions that make or mar society and the nation.

Respectfully submitted.

A. Backus, *Chairman.*

Morning Session, Tuesday, August 17, 1909.

President J. L. Ellsworth called the meeting to order at 10 a. m.

J. Withycombe, Corvallis, Oreg., read the following paper:

The Farmers' Institute with Respect to the Practicability and Advisability of Undertaking to Establish and Conduct Demonstrations in Stock Feeding and Management, and in Field, Orchard, or Vineyard Production, Either in Cooperation with Farmers or by Direct Control.

I will at the outset briefly give you the reasons why I am a convert to demonstration work, that is, cooperative demonstration work in connection with farmers and farmers' institutes. We have been holding institutes for a number of years in this State in a county that had more first-class apple land than any county in the State, and we had

called the attention of the owners of this land, farmers in general, to the possibilities in growing apples, but in spite of all efforts we could not induce a single man to go into commercial orcharding in that county. We finally made the offer to any man who wanted the cooperation of the horticultural department and would prepare 10 acres of land and follow the instructions of the department as to the care of young orchards, pruning, spraying, and the culture method, we would supply the trees and send our man occasionally to supervise the work. The result was that two farmers agreed to comply with the conditions and two orchards were planted in that county. One of those orchards last year was used as a field demonstration for pruning, and we found it intensely interesting, and one of the most popular features of the institute. I may say since those two orchards were planted several have taken up orcharding work, and it has doubled the value of the land in those localities. It shows sometimes that you have got to take radical measures to convert the farmer. I am a strong convert to farm demonstration work.

The institute has been a mighty factor for good. It has not only brought greater revenue from farms but it has also enriched the lives of farmers. After all, there is something more in the life of the farmer than simply to make money. True the farm must be made to pay, but the true inspiration of right living upon the farm can not be measured by a monetary standard. To learn how to make more money on the farm is good, but to know how to appreciate a correct knowledge of agriculture is better. Farmers' institutes, like all educational institutions which are up-to-date, must be progressive. From a crude beginning many valuable features of institute work have been developed. The itinerant school and demonstration train are perhaps the more recently developed features of the work. All of these are good and are active factors for the general upbuilding of a substantial agriculture. The institute is to be congratulated that hitherto it has been free from fads. While its work has been characterized by a wide variation in methods, nevertheless wholesome practical results have been secured. There is no question as to the economic value of the institute. It has added millions of dollars to farm values and has brought the sunshine of contentment and prosperity to innumerable farm homes. Despite the great work that has been accomplished the field is an inviting one for still greater exploitation and elaboration.

The purpose of this paper is to direct attention to the possible field of usefulness of cooperative demonstration farm work in connection with farmers' institutes. This is an age of specialization. Not only are individual farmers becoming specialists, but farming communities are rapidly being characterized for special productions. For example, in one locality in this State 400,000 pounds of onion sets are grown and shipped annually. In another comparatively small valley $500,000 worth of fruit is grown annually. In one county with a small area in cultivation over a million dollars' worth of dairy products are sold annually. This perhaps constitutes fully nine-tenths of the value of all agricultural productions of the county. In another county between 3,000,000 and 5,000,000 bushels of wheat are produced annually. This indicates a tendency toward community specialization in crop production. As a natural consequence the farmers in these different localities would be especially interested in problems relating to their particular line of endeavor.

Agriculture being a strictly progressive vocation is constantly confronted with new problems. It matters not, then, how well farmers may be succeeding there are always questions upon which information is greatly desired. To meet occasionally and discuss these various problems is good, but an opportunity for practical observation is better. Thus if it be at all feasible to maintain cooperative demonstration work along dominant lines of production in the various sections, it would be of inestimable value. This work could be conducted at accessible points in the different localities and form the basis for practical agricultural education. The very fact that farmers can without much effort see the things in which they are greatly interested will have a far greater significance than if they could simply hear about them, as is the case in an ordinary lecture.

The cooperative demonstrations in the respective localities should be conducted along the lines of the dominant agricultural industries of that neighborhood. For example, in dairying districts demonstrations for economical production of crops for the dairy herd may be undertaken, also modern methods for the general management of the herd may be employed. Then on a certain advertised date let there be an institute held, so that the various phases of the work can be explained. Thus the dairymen of the neighborhood can secure a valuable ocular demonstration.

In fruit and poultry sections similar demonstrations can be made. Each cooperative demonstration would be really the center of information for the neighborhood. The value of these cooperative demonstrations would be influenced largely by the

personal equation of the one who directed the work. These demonstrations could be made to include a wide range of subjects. It may not be confined strictly to matters relating to the financial betterment of the farmer, the home should not be neglected; hence cooperative demonstration for the beautifying of the farm home may be included. The object of the work should be to enrich the farmer's life as well as to increase his bank account.

It must be admitted that better agricultural practices have resulted from the institute, but the field of agriculture still presents a boundless opportunity for the study and application of improved methods on the farm.

The secretary then read the following paper from C. H. Tuck, Ithaca, N. Y.:

What Plan Could be Adopted by the Institute for Organizing and Conducting Demonstration Work?

In order to discuss demonstration work logically it is necessary to determine what is meant by the expression "either in cooperation with farmers or by direct control." According to experience in the State of New York it is difficult to conceive a direct control which would not intelligently enlist the cooperation of the farmers. On the other hand, cooperation with the farmers does not necessarily prevent direct control, if by direct control is meant the control of the moneys and the general management for any of such demonstrations. This seems only a combination of the ways indicated in the original proposition. Experience has shown again and again that a program of any sort for farmers, as indeed for any one, reaches its maximum point of efficiency when it intelligently enlists from the start a real and vital cooperation of all the interests which are properly concerned in the movement. The time is fast going by in many sections when mere propaganda will suffice for an intelligent people. The best advisers are being put to it to give answer to conditions of which they have no direct information and in the face of which many times general advice is far from the mark.

A knowledge of the local facts is necessary if information of immediately practical application to particular sections is to be imparted. Not only is a knowledge of the local facts from the standpoint of specific information necessary, but further and even in a more significant way it is extremely necessary to know the local leaders; those substantial, practical farmers whose success is thoroughly well recognized by their neighbors. To my mind one of the most serious mistakes is the sending to a community year after year those so-called "exotic teachers," in the main knowing neither the local facts nor the local leaders, telling their story as they used to tell it, but knowing nothing practically in the line of immediate application of those points which they would have impressed. I submit that the greatest force in institute work lies not in the information to be presented, but in the power of the conductor to associate himself and his staff in an intimate way with the very life and growth of the local interests. Commissioner Pearson of the State of New York established in the first year of his administration for the first time in the history of institute work in the State a system of county conferences—the home rule idea. A conference was called of the officers of the different agricultural organizations and in joint meeting the place, the subjects, and in some instances the teachers for the institute work in that section were determined. This admirable step in initiative should be supported with persistence and enthusiasm. Under these conditions the conductor may intimately associate himself, if he is of the right kind, with the people and their interests. He should, in so far as he can, select those sensible, strong, young farmers who are to be found in every community and with whom a little encouragement is one of the most available pieces of work that the institute staff can do for the community. Select these promising young men, get them interested in the management of the institute, in certain instances place them on the program for the benefit of the example to other young men in the community. A special feature of this point will be made in certain counties in the State of New York during this coming winter. In this way we will cooperate with all legitimate local forces that would upbuild agriculture, and when the outside teachers have come and gone definite organization, definite personal influences, definite lines of progressive work will have been left intact in the community for the furtherance of its best interests. So when the next institute season comes around a definite advance, industrially and educationally, will have been secured. To raise up in the community a few young men with a knowledge of their own strength, to place them on a level where without any embarrassment they may meet the young men in a neighboring city, and give them that confidence that will inspire them to look after the public interests of their own community rather than to allow such interests to be preyed upon by outsiders with no deep

concern for the community, is the greatest and most enduring success that may crown the labors of an extension staff.

I have submitted to you the necessity for a knowledge of the local facts and the recognition of the local leaders that I might make myself clear as to such procedure in institute organization as might permit of the most efficient manner of conducting demonstration work.

There are three steps to be recognized in the pedagogy of extension teaching, (1) the use of the spoken word to engage the individual's attention, (2) the actual demonstration to convince him on what you have tried to persuade him, and (3) the pursuit of such correspondence, logically arranged reading courses, and study of bulletins and books, as may seem best in each case.

The method of conducting the demonstration, therefore, falls under the second head. In a State like New York practically all of the demonstration work in the growth of plants must be done during the summer and fall. That in animal production may be carried on fairly effectively in the winter. In the summer work Commissioner Pearson has directed practical field demonstrations to be conducted in cooperation where possible with regular agricultural meetings. At the present date we have cooperated with fruit growers' associations and expect to do so during the rest of the summer and fall. The advantages of these are that the persons interested are expecting any way to spend the time at the meeting. It becomes a simple matter, therefore, to advertise a special feature of the demonstration at some convenient time during the day or perhaps the following day after the regular exercises, where a two-day meeting is held. At the appointed hour the teacher in charge will take a group of persons to an orchard, a potato field, or a corn field, as the case may be, to study those particular problems which can best be understood by actual demonstration.

In many instances we cooperate with granges, arranging for demonstrations by practical teachers in connection with the regular program. We have demonstrations arranged especially for such work. While in some instances we have large crowds, in many instances we have by choice a small gathering, from 25 to 50 farmers gathered in "shirt sleeves" neighborly fashion, with a "shirt-sleeved" teacher. It will be a workers' meeting, for the purpose of improving the material or commercial situation. These meetings are arranged on the part of the representative of the department of agriculture through correspondence or visitation with such organizations as it may desire to work with or through correspondence directly with such local leaders as any previous knowledge of the case may make advisable. The organization of this work is entirely simple. The main point lies in the ability of the teacher to "make good on the sod." We will do in this work two things; first, show the farmer that, figuratively speaking, we can plow as good as he can, and, second, we will, literally speaking, force out from the instructing staff those persons who can not plow as good as he can.

In arranging for demonstration in the winter time, it may be carried on effectively with the regular institute, simply by adjourning all or part of the meeting to a stable or poultry house, avoiding a large crowd, and having that practical teacher who can really do his best work with his tools at hand, that is the tangible problem within reach.

The actual manipulation of this demonstration work itself is therefore the easiest end of the whole problem. Real success in the institute, in the organizing and conducting of demonstration work, in the field or the barn, will depend upon a careful study of the local facts, a knowledge of the local leaders, and a presentation of that information which in practice in that community will promote an enduring improvement.

W. T. Clarke, Berkeley, Cal., then read the following paper:

The Practicability and Advisability of Employing Experts to Devote Their Entire Time to Visiting Farmers and Offering Advice Respecting the Improvement of Their Practice.

In taking up the subject of this paper, the matter should, I believe, be approached in the following way. First, is it advisable to employ experts whose duties shall be as indicated in the title, and, second, is the employing of such experts for these duties practical? I shall endeavor, then, to present the subject in this sequence, though it must be remembered that in the main the arguments for or against the work under discussion must be based upon personal experience and observation. This personal experience may, in the case of one individual, have led to certain conclusions, and in the case of another to quite opposing conclusions.

I advocate most strongly the advisability of employing experts to devote their entire time to visiting farmers and offering advice respecting the improvement of their practice, because the importance of this branch of productive occupation is so vast and because its needs are so great. In a discussion of this character, personal experience must count for something, and my own experience leads me most heartily to indorse the idea presented. It has been my duty and honor to represent the college of agriculture of the University of California in certain lines of cooperative experimentation. The carrying on of this work necessitated my taking up residence in the region where the experiments were being made, and there I had to "visit farmers and offer advice" along certain specific lines. My duties did not end, however, when these specific lines were covered, for the farmer always had plenty of questions to ask and insistently demanded information. In certain of these cases, which may be called demonstration experiments, I have, in addition to the regular visitation work, established regular office hours for consultation. My experience in this work points conclusively to the fact that missionary experts are needed; yes, are emphatically demanded, and until we have met this demand we will not have done our whole duty.

No question exists as to the advisability of the work indicated, and now comes the question of its practicability. It will perhaps allow us to approach this portion of the subject in a more understanding way if we recognize the fact that the practicability of any action consists in its "capability of being effected or accomplished," and further, for the action to be practicable, it should be "of practical value or advantage."

The question then is, can the work of the advising expert be effected or accomplished? In a broad way, we can answer this question in the affirmative. We have but to consider individual cases that may have come into our own experience to find that in a small way this work is now being done. Not perhaps in the full and complete fashion that it should be done, nor yet perhaps avowedly with the object in mind that we are discussing here, but nevertheless, the expert is in the field here and there and his advice is being heeded by the occasional farmer. In the State of California it is quite the usual thing for the larger and more important fruit shipping firms to send men out through the orchard districts to consult with and advise the orchardists in regard to their practice in the matter of spraying, irrigation, and handling their crops.

In certain of the counties of this same State of California are found what are known as horticultural commissioners. The duties of these men are of police character. Upon them devolves the work of horticultural inspection and the enforcing of laws in regard to the suppression of insect pests and plant diseases. While their duties are, as I have said, of a police nature, yet they are constantly called upon to offer expert advice, and, indeed, in many instances this phase of their work becomes of more value to the community than their regular and legal work.

Most of us are probably familiar with what is being done by the United States Department of Agriculture in various parts of the country. I refer especially to the studies of plant diseases and the experiments in insect control. In the matter of the study of pear blight in my own State, a corps of experts has been in the field during a very considerable part of the past few years. These men have had one object in view, the study of the pear blight, and of giving advice directly to the farmers in the matter of its control. In spite of the single-purpose object of their work they have had to do much in the way of advising the farmers in regard to other items of their practice. They have had to act the part of missionaries. Experiment station workers in the different States know that sometimes, to the crippling of their work of investigation and experimentation, much of their time must be devoted to this matter of giving advice, and they know too that this can be most effectively done by personal visits and interviews with the farmers. A letter is a good thing, sometimes, but a direct talk with the seeker for information usually accomplishes more than the writing of many letters.

Incompletely and by various agencies then this work of carrying expert advice to the farmer is now being done and its practicability has been shown in the fact of its being effected or accomplished.

Little need be said on the second phase of this subject of practicability, that is, that for the action to be practicable it should be "of practical value or advantage." I take it that this word practical in this connection means about this, that the returns in actual money value from the contemplated action should largely exceed the necessary expenses of such action. Will the results justify the expense? I think, judging by the little that has been done along the suggested lines of action, that we can unhesitatingly answer this question in the affirmative.

Farmers' institute work, if we analyze it and search out specific instances, will give us frequent illustrations that prove the point at issue. Herd testing and scoring and the use of the Babcock test is to-day traceable, in many communities, to the work of experts who have advised the owners to take up this line of endeavor, leading to

better returns from the dairy herd. We know that the results have more than justified the outlay in these cases. In the year 1902 the experiment station and college of agriculture of the University of California was called upon to assist in the suppression of an insect that was causing a loss of many thousands of dollars annually to the peach growers of that State. Experts were sent into the field and it became their duty not alone to study the pest in question but to advise the orchardists as to the best practice to follow in controlling it. It cost the station in the neighborhood of $1,500 to do this work, but it was successful. The methods advised by the experts have become the common practice of the orchardists and a saving of $75,000 to $100,000 a year accrues to them. The result has justified the expense many times over. I might multiply these illustrations indefinitely, but this is not necessary. To each one of us, undoubtedly, have come experiences that prove that this work now under discussion is practical in the fullest sense of the word.

Of course, I recognize that much of detail remains to be worked out before this action can become general; I recognize that ways and means to finance the work must be devised; that it will be a gigantic undertaking to get the proper men and women to put in the field. The work is advisable, it is practicable—its development calls for our best and most careful thought and consideration.

In the absence of G. C. Creelman, Guelph, Ontario, and his failure to send in his paper, G. A. Putnam, Toronto, Ontario, gave an extemporaneous talk on the subject as follows:

What Plan Could be Adopted by the Institute for Organizing and Conducting Advisory Work?

While we have no men engaged by the institute branch to visit the individual farmer for the purpose of looking into and giving advice and instruction suited to the conditions met with, the agricultural department has such men employed in other branches who are devoting their time to visiting the individual farmer and who are thus in a position to give the institute branch advice and information based upon their observations which will be of particular value to us in outlining work for the various districts.

The fruit branch has, this year, engaged several men, some graduates of the college and some practical farmers without college education, to take a census of given districts at the same time that they are instructing the farmers in up-to-date methods of culture, spraying, marketing, etc. If one of these men visits a farmer who is making a mistake in his methods of spraying, he remains with that farmer probably a half or a whole day and helps him fix up his machines, and starts him on the right road again. The farmer, it may be, has started out with the intention of spraying thoroughly, but he has met with some difficulty and has not taken the time to go to some neighbor farmer who has made a success of apple spraying to get assistance. He is glad to get the advice of the specialist. The specialist, as you will see, has a splendid opportunity for collecting information which will enable us to carry on institute work more effectively.

We are also conducting similar work among the dairymen. We have 32 men in the field who are devoting their whole time to the makers and producers, instructing the makers in the best method of manufacture, and the farmers in the care of milk, and are looking into dairy conditions generally in the district covered. If they find that producers have sent in milk which will lower the quality of the whole make of cheese for the day, they go to the producer and tell him wherein he is making a mistake in methods of producing or caring for the milk.

The departments of education and agriculture have cooperated in placing graduates of the agricultural college in 11 high schools of the Province. The duties of these men consist in teaching agriculture to such of the high school pupils as desire to take instruction in agriculture in preference to some other branch of high school work. During the school session to a certain extent, but more especially during the holiday season, these men are advising with the farmer as to methods of combating weeds, improvement of seed, underdraining, introduction of fertilizers, the testing of cows, the formation of farmers' clubs, etc. While doing this work they are enabled to look into the agricultural conditions and advise the department as to the most important lines of work for the institute lecturer to follow in the regular institute campaign. These men have offices and reading rooms in which will be found standard works on agriculture, copies of the leading agricultural papers, and other literature and samples of value and interest to the tiller of the soil. The farmers are always welcome to come to these reading rooms and offices, either to advise with the specialist or to read the literature or look over the samples and specimens to be found.

The placing of specialists in agriculture in various localities has resulted in interesting a much larger proportion of the farmers in the work of the agricultural department; and the farmers who are most in need of instruction have been induced to follow better methods—a result which the institute alone has not been able, up to the present, to accomplish to the desired extent. If we are to reach the man who has not, after twenty or twenty-five years of institute work, thought it worth his while to attend the institute meetings, there is no more effective way of doing this than to send a specialist to advise with the individual and to conduct experiments in the locality which will be an object lesson for all who will observe.

There must be cooperation between the institute and all these other forces for agricultural education and development if we are to do the most effective work.

Discussion.

W. L. Amoss, of Maryland, outlined the plan of handling a car and movable schools in Maryland, and explained how the services of one man could be utilized throughout the entire year.

L. R. Taft, of Michigan, said that in Michigan they utilize the entire services of three men for field extension work.

The following paper was read by G. A. Gigault, Quebec, Canada:

The Practicability and Advisability of Introducing Prize Contests Along Agricultural Lines Among Adult Farming People.

In the Province of Quebec the agricultural societies are authorized by law to hold exhibitions as well as competitions respecting crops and the best-kept farms. At first the law was that one year exhibitions would be held and the ensuing year farm or standing crop competitions, and so on alternately. Unfortunately the law was changed so as to allow annual fall exhibitions. There are 77 agricultural societies in the Province, and to-day the great majority hold fall exhibitions every year. There are, however, many which hold at the same time competitions for standing crops or farms. We have tried to bring these associations to encourage more liberally farm or standing crop competitions, but exhibitions are very popular and absorb the greatest portion of the funds of the societies.

The question of the merit and of the choice of competitions to be fostered has been treated very often in the agricultural conventions, and always the best agriculturists have acknowledged the usefulness of competitions respecting standing crops and farms. In an international agricultural convention held in Paris such competitions have been considered far superior to fall exhibitions to encourage the improvement of agriculture.

The land improvements are the source of all other improvements. They increase the yearly revenue, and competitions should be organized so as to promote such improvements. That farm and standing crop competitions produce good results there is no doubt. In every county where they have been held many years we are delighted to see nice clover fields and other signs of the good management of the farms. The county of Montmagny has a society which has held many such competitions. A few years ago it was visited by an agricultural commission whose members say in their report that they have admired the numerous good farms existing in that county.

Agricultural merit competitions.—Besides the prize contests organized by the agricultural societies and farmers' clubs, the Province has the agricultural merit competition. For that purpose the Province is divided into five districts. The farms of the competitors are visited by three judges appointed by the government. One district is visited every year. Only those who have won prizes in the county competitions for the best-cultivated farms are allowed to compete in the provincial competition. The lieutenant-governor in council is authorized to confer certain distinctions upon those who have been successful competitors.

Such distinctions consist in:

(1) A diploma and a silver medal for the person who at the competitions has obtained the degree of "distinguished merit."

(2) A diploma and bronze medal for the person who has obtained the degree of "great merit."

(3) A diploma for the person who has obtained the degree of "merit."

"Distinguished merit" is granted to the person who has obtained at the competition 85 out of the 100 points allowed for perfect cultivation. "Great merit" is granted to the person who has obtained 75 per cent of the same points, and "merit" to the per-

son who has obtained 65 per cent. The person who in any of the divisions has most distinguished himself during the five years next after the date he received the diploma of "distinguished merit" in maintaining the perfection in cultivation by which he earned his honorific distinction, may, upon the report of the judges, receive a gold medal and a special diploma. The competitor, in making his entry, must sign a form in which he replies to the questions it contains; he is requested to add a small plan or outline of the farm which he intends to enter. The report on that competition has illustrations showing the buildings and live stock of the farms of the most successful competitors. It describes also their methods of cultivation.

A certain number of points is given for the bookkeeping accounts kept by the competitor. In their decisions the judges are guided by the perfection of the cultivation. They should endeavor to ascertain how far the competitor may serve as a model or example by the way in which he works his farm without exhausting it, and at the least expense compared with the net profit he derives from it.

Field-crop competitions for the improvement of seeds.—In 1908 the department of agriculture offered a special grant to the agricultural societies which would hold during that year competitions respecting standing crops. The main object of that special grant was:

(1) To stimulate the farmers in the growing of choice seed grain.

(2) To encourage the practice of growing seed for next year's crop separate from the main crop, using only the best obtainable seed, sowing it on the best prepared land, and the cleanest, allowing it to thoroughly ripen, and thrashing and storing separately.

(3) To obtain pure grain, i. e., free from other varieties, the presence of which can best be detected when the grain is growing.

(4) To encourage the use of seed from heavy yielding strains.

(5) To promote the sowing of seed from clean, vigorous crops of uniform stand, and with bright stiff straw in the case of smaller cereals.

(6) To encourage careful and intelligent farming and the production of grain free from weed seeds.

Regulations governing the competition.—(1) The competition is limited to one crop, to be selected by the society which should be one of the most important to the farmers of the district. Entries for competition must consist of a field not less than 3 acres, and where potatoes are entered, the minimum plat not less than 1 acre. Selection is made from the following crops: Wheat, oats, barley, corn, peas, clover, and potatoes.

(2) Competition is limited to the members of agricultural societies. Competitors are allowed to make entry in only one society, and but one entry can be made by each competitor.

(3) The department of agriculture grants $50 to each of the societies above mentioned. This special grant is employed in paying prizes of not less than $15, $12, $10, $8, and $5. Prizes are awarded by the judges only to fields deserving such prizes. The plats are visited by judges appointed by the department of agriculture of Ottawa. Last year eighteen societies complied with the regulations and received the government grant. This year forty-five societies have applied for the grant and transmitted lists of competitors.

Those competitions are very useful and popular. Some of the successful competitors have sold at a high price the produce of their fields entered for competition last year.

Special competition for girls and boys.—The department has also agreed this year to give a special grant of $15 each to ten societies for a special competition for girls and boys for exhibits consisting of selections of wheat and oats. Each exhibit shall consist of a sheaf of wheat or oats, as the case may be, composed of a sufficient number of plants to make a compact sheaf of approximately 8 inches in diameter. These plants are to be selected by hand from the standing crop and must show the full length of straw (roots not included). In addition to this sheaf a gallon of thrashed grain from the same field or plat is called for. Exhibitors are advised to select and thrash by hand a sufficient number of good evenly ripened heads to give the above amount of thrashed grain. This seed may be sown on a plat by itself in the spring of 1910, so as to provide a place from which extra good plants and seed for next year's exhibition may be selected.

Milch-cow competitions.—The department gives also a special grant to agricultural societies and farmers' clubs which organize milch-cow competitions, taking into account the yield of milk and, if possible, its richness. The cows are milked three times, at regular intervals, before judges. The first milking does not count. Last year 6 societies and 26 farmers' clubs received the grant, and this year 6 societies and 47 farmers' clubs have applied for that grant.

Seed fairs.—Another special grant is also given for spring seed fairs organized every year by six or eight agricultural societies. Lectures are given at the same time to farmers attending those fairs, which produce very good results.

Conclusion.—There are 624 farmers' clubs in the Province of Quebec. They do not hold fall exhibitions. Besides organizing farmers' institutes they generally buy and own thoroughbred live stock; a good many hold standing crop competitions. The grant they receive is from $25 to $50. If they had more funds at their disposal they could encourage more liberally useful competitions.

As to agricultural societies, it is difficult to bring them to favor, out of their funds, competitions which would promote the best interests of agriculture. Too often hotel keepers and horsemen exercise too much influence over their management. What those men want before all is to attract big crowds. I would not advise an increase of grant to agricultural societies and farmers' clubs otherwise than by special grants for special purposes. Seed fairs, field crop competitions for the improvement of seed, milch cow competitions, and I may add the most useful competitions, are maintained through special grants given for those purposes. Only a certain amount, and not a big one, should be left at the disposal of the agricultural societies and farmers' clubs. Another line of conduct leads to the waste of a large portion of the public grants. In Ireland the use of the government grants is controlled by the department of agriculture, and such a policy has produced most satisfactory results.

O. M. Olson, Pullman, Wash., read the following paper:

A Plan for the Introduction of Prize Contests along Agricultural Lines among Adult Farming People by the Farmers' Institutes.

Any considerable extension of effort on the part of farmers' institute work must recognize its present importance in the progress and success of agriculture. The farmers' institute movement has long since passed its infancy and stands to-day a very important factor in agricultural extension work. Its success lies and will continue to lie in coming close to the farmer and bringing in its message the practical application of the valuable truths of agricultural research. At first much of the work was abstract, but gradually the trial of various ideas, with the retention of only the fittest, has developed a system that is a strong element in agricultural education. To progress whenever possible calls for united effort.

It is not enough to bring the practical phases of agriculture to the farmer, or to bring to him the latest truths in agricultural research, but to induce him to make use of those truths and to use the things that he actually needs.

It appears that all movements embodying within their purpose the idea of education and inspiration to the farming population can be made of value; that anything we can do to develop the possibilities of communities, to induce habits of thrift, to conserve the natural resources, and to promote greater social happiness certainly comes within the realm of institute work, providing always that results outweigh the cost. This, I believe, has always been the purpose of institute work, so it is therefore not a material change, but to further its purpose, that any new phase of work should be undertaken.

But why should institute work undertake to include contest work? It has long been recognized that demonstration work is a success and very effective. It is not enough to present a thing to the ear but to the eye if possible. All incline more or less to the old adage that "seeing is believing," and especially is this true with the farmer. Having been made the butt of ridicule and the basis of humbug so often, it is no wonder that he becomes skeptical and hesitates when told to do this or that. Minnesota farmers shook their heads when told they could grow corn, but when they saw it they believed it, and to-day they are enthusiastic and eager for more concerning it.

If contest work is made to provide a demonstration to the public it seems worthy of consideration. Having settled that this form of work is desirable, we are confronted with the development of a plan. How can it be organized to secure the desired result and other possibilities as well? Any plan for industrial contests, whether for the youth or the adult, should deal with things that are practical. We need new knowledge, but we need also to put our present knowledge into more practical form. Even though contests be inaugurated to develop certain possibilities in a community, they should conform to the practical in every phase.

A contest should provide some stimulus for individual effort or a stimulus for certain farmers to make a greater effort and become a good pattern for their neighbors. But few farmers are free to take the initiative in farm work, yet the balance are ready imitators of the few. Farmers are inclined to do a great many things because they have observed that it is a practice of some successful farmer in the neighborhood. Any farmer, who is a farmer at all, knows who is the best farmer in his community. Why? Because he has observed his way of doing things and he has seen the results.

In other words, the power of doing a neighbor good rests not with telling him what to do, but in doing it for yourself and letting him see what it will do for you. We can not go out and set a good example to every farmer, but I believe it possible to introduce contest work whereby nearly every farmer in the State will have an opportunity to observe progress resulting from it.

I do not assume that the plan I propose is perfect; nor do I believe that such a one could be fully worked out here to-day. It no doubt will be of slow growth, accumulating an idea here and another there, until it presents a system that is very effective—one in which the proposed plan may be entirely lost sight of. I would make it a contest of farms and farming operations covering a year rather than of any individual industry or branch of farming. In this manner it would become more widespread, more educational, and less liable to be made partial to favored sections and industries.

It may be claimed that model farms are now being conducted in demonstration and experimental farms, but they are too often conducted under conditions that the farmer can not hope to secure, something the farmer knows full well. The best model farms of to-day are those owned and operated by progressive farmers. To make the contest more truly applicable to the ones we wish to reach it should restrict the number of acres, say 20 to 160, and require that it be operated by the owner, who shall maintain his residence on the farm and conduct it as his chief source of business.

In the farming to be followed out there should be maintained a reasonable diversity of the approved industries and industrial possibilities of the locality with a just consideration for the stability of prosperous conditions. In the making of awards the following should receive relative consideration: Evidences of practicability, continued prosperity, diversity, business management, general appearance, convenient arrangement, not forgetting home conditions and social happiness.

The unit of division for the contest should be the county, for the reason that conditions are comparatively equal, and the plan assumes that the county has an interest in the work and must show it by assisting in the awards and the raising of the prize money. Counties should be grouped into districts where climatic conditions and crop productions are comparatively similar and equal, and a district contest held among the winning farms of the counties in the district.

The state, by appropriation, shall furnish the prize money for the district contests and one-half the prize money for county contests, to be distributed as follows: A county prize in every county, in which the county will raise a certain amount (not less than a certain sum of dollars) and will conduct the county awards. To such counties there is given an equal amount as the amount raised for prize money (not to exceed a certain sum). For a district prize there shall be awarded the sum of so many dollars for every county in the district that conducts a contest, the award to be made by the institute department.

So much for the contest itself. But what of results? Have we, by our extra or diverted efforts, gained anything? Have we secured material results to warrant the expense? Of this only time can tell. While movements of this kind can not be measured by dollars and cents, this we do know, that a community of interest will have been aroused before a county prize need be paid.

It appears reasonable that a state-wide contest of this kind must stimulate the rural occupation; that, if rightly conducted, we will have stimulated or developed in communities possibilities which would have remained dormant much longer; that it may bring about the utilizing of local or neighborhood experience more extensively; and that it may lead to the elimination of some of the present drudgery of farm life. We have every reason to believe that the competitive spirit will, as in the past, continue to cause progress.

The result of a plan or movement of this kind must not be measured by the good to the one in fifty who becomes a prize farmer. The other forty-nine contestants have progressed and set a good example that is bound to be effective.

In conclusion, whatever may be said of the results or its feasibility, its success will depend upon the manner in which the farmers take hold of it. In so far as we can interest them will it be successful, and only to that extent. Unless we receive a response from the field of labor our plan is in vain.

H. L. Russell, Madison, Wis., read the following paper:

The Practicability and Advisability of Holding all Summer Institutes in the Barns, Orchards, or Open Fields in Immediate Contact with the Conditions under which Animals and Crops are Produced.

There is so much universality in these respective subjects that it is very difficult to suggest anything new. I think there is no question but what we all agree that it is a very desirable thing indeed that we introduce new features as far as possible into

our work. We can take a lesson, I think, in this matter from the housewife. She has flour and salt and pepper and it may be a few other things at her command with which she has to compound the various menus which she puts before us. If we were to be fed entirely upon bread and potatoes or meat and potatoes it would get to be a monotonous diet, but she has learned by the artful association of these ingredients how to put before the household an appetizing dish, and I believe we must put our educational theories a good deal the same way. We have got to take the ingredients which contain any good to the farmer and hash them up in such a shape that they will be attractive and presentable, and that calls for the continual variation in the program that is presented to the farmer in order to induce him to improve his methods.

The demonstration method is unquestionably the most successful way in which that can be done. The shortest route to the brain is through the eye, and even the most intelligent man comprehends what you desire to bring before him very much more quickly and more thoroughly if it is presented to him from an objective point of view. If that is true with the person who is familiar with facts and figures, who can analyze data and can understand tables and the printed page, it is much more true with the farmer who gets at things through his fingers rather than through the other processes of thought. There is therefore no question, so far as advisability is concerned, that the demonstration method of presenting the subject is incomparably superior to the lecture method. That has been tested over and over again.

There are certain facts that are particularly desirable and particularly easy of bringing before the farmer. The demonstration farm, for instance, is one of the very best methods of illustration. In Wisconsin that has taken form through the establishment of county demonstration farms. In place of taking the farm of the best farmer in a community, we go to the county poorhouse farm—that is, the insane asylum, the county insane asylum—which usually has a large tract of land. This is a piece of land that is owned by the community as a whole rather than by an individual. Every person in the county has more interest in the development of this particular farm than he would in the development of a farm of some particular neighbor. Therefore in this way we obviate part of the jealousies which might arise if the farm of a certain individual were selected. That farm is used as a basis of operation. The agricultural department requests the superintendent to lay out a particular method of rotation and proper arrangement of his fields. We give him grain of selected character, and then the farmers are brought in the course of the summer to this demonstration farm for a farmers' picnic. These picnics are in progress during the months of July and August all through the State. The farmers come to this county demonstration farm, and they are coming in large numbers. It is also possible at this farm to carry out cooperative fertilizer experiments. Wisconsin, in spite of the fact that it is a prominent dairy State, is already suffering from loss of soil fertility, and it is necessary to bring the farmers to a realization of this fact. This can best be done by making comparative fertilizer tests and by application of rock phosphates combined with manure. In a surprising way this test has demonstrated the necessity of utilizing those fertilizers, and so it is possible through the demonstration to bring to the realization of the farmer the truth we want to convey in a way which we have not been able to do before.

One of the men in my particular department has a means of illustrating what has been possible to do. Wisconsin, as you know, is a prominent dairy State. The disease of bovine tuberculosis is one of the main scourges. Years ago when we began the consideration of this question the farmers had absolutely no conception of what it meant from an economic point of view. We had prepared bulletins treating this subject. We distributed them widely and they were well illustrated, and as far as it was possible to do by the printed page, we felt that we had in the distribution of this material shown good work, and yet what was the result? We made so far as the tuberculin tests were concerned less than 1,000 tests a year as the result of this paper campaign. We made up our minds that if we were going to combat the disease of bovine tuberculosis successfully from an economic point of view, we had to adopt some other method, so we began the demonstration campaign, which consisted of going out and taking a herd which had been admitted solely and absolutely on the basis of the test applications of the tuberculin tests, taking animals from that herd and slaughtering them before the people so they might see for themselves the ravages of tuberculosis in dairy tracts. This was done at the state fair, and at various county fairs, before farmers' institutes, before any and all kinds of organizations in which we could get the actual stock owners together. We minimized the test part of the question, but we emphasized the economic side of the question. We told the farmer: "You can not afford to allow the disease of tuberculosis to remain in your herd for the sake of the herd itself, and here is a demonstration of it." An animal possibly in

prime condition, which had reacted to the test, was selected and the internal condition of the carcass demonstrated the presence of the disease. The test and demonstration convinced those people in a way that no amount of lecturing would have done. The result was that in the first year after we began the public demonstrations the tubercular tests were increased to many thousands. We could not have gotten these results had we not adopted this demonstration campaign. These illustrations show that so far as advisability is concerned there is absolutely no question but that in farmers' institute work we should adopt demonstration methods.

As to the practicability of carrying that out under the organization of the farmers' institutes, it will depend entirely upon what organization you have. If your farmers' institutes are, as they are with us, while nominally under the control of the agricultural college, yet under the immediate direction of practical farmers whose time is largely taken up during the summer months by their farm occupation but who give to this work a portion of their time in the winter months, such demonstration methods can not obtain. But, on the other hand, if your farmers' institutes are under the direct control of your agricultural college where you have men who can give their entire time to this work, and who have ability to give expert information, then I believe that the institution of these demonstration methods is going to be replete with much more success than with the methods which have been previously followed. I am satisfied from our own experience that this is true. With us this demonstration type of the work is being carried on by the agricultural college proper. We now have an agricultural extension department which is coordinate in importance with the experiment station, yet connected with the teaching portion of the college, so that the college stands as it were on a three-legged basis, in which the extension is regarded as coordinate in importance with the internal work and the research work. The men who carry on this extension work are paid commensurate with what men are paid in the other departments.

Another matter of great importance in this extension work is that we should send out to the farmer men of experience. It will not do to send out a fledgling from school to these practical men in farm work. We have got to have men of mature thought, men of judgment. So in picking extension men we try as far as possible to get the very strongest kind of men for this work that we can possibly get. Some of the very best men in the university are spending a large part of their time in this extension work, and I believe that when we raise the salaries of some extension men to a point commensurate with what we are giving research men and administrative men and the teaching force, we will be able to command the services of men of ability. This is absolutely necessary for conducting this kind of work.

In the absence of H. M. Cottrell, Fort Collins, Colo., his paper was read by Secretary Hamilton, as follows:

What Plan could be Adopted by the Institute for Conducting Demonstration Meetings?

We have found it unsatisfactory to hold institutes in fields or orchards. Our summer meetings average an attendance of considerably over 100, and often 300 to 500 attend. We tried holding the meetings in the fields, but found the damage to crops too great. We prefer to hold the summer institutes in groves close to the fields or orchards. Before the time called for the opening session the institute speakers make an investigation of the farms and stock of the neighborhood to become familiar with local conditions and needs. The talks are adapted to meet the particular needs of the community. Attention is called to various fields and orchards, good treatment explained and commended, and defects pointed out. In orchard work pruning demonstrations are made by taking branches of trees on the platform and pruning them as the trees in the orchards should be pruned, explaining the principles at the same time. Similar methods are followed with garden and field crops. When live stock is under consideration, the animals are brought in front of the platform, examined, discussed, and judged. The same is done with field crops and with fruit. We usually limit these institutes to one day, as that is all the time farmers feel that they can spare in the crop-growing season. Sessions are held from 10 a. m. until noon, and from 1.30 to 4 p. m., each lecture being limited to thirty minutes. When the farmers are not too busy a night session is held. In Colorado we have found it impracticable, in most localities, to confine an institute to the consideration of one topic only. The difference in altitudes, soil, and shelter conditions are so varied that most places demand information on several lines.

DISCUSSION.

John Hamilton, of the United States Department of Agriculture, emphasized the necessity and advantage of ocular demonstrations in conveying information that is to be put into practice.

J. W. Stewart, of Florida, spoke of the good to be derived from prize contests among boys.

W. L. Amoss, of Maryland, remarked upon the importance of demonstrations and told how he had enlisted the newspaper men in the work.

Andrew Elliott, of Ontario, claimed that demonstration work was most valuable when done by a farmer among his neighbors.

F. S. Cooley, of Montana, told of the good results following demonstration farms for dry-land farming.

G. A. Cole, of Arkansas, remarked on the wonderful progress obtained by demonstration work in rice land previously considered worthless. Demonstrations on the cultivation of corn and cotton also gave surprising results.

S. A. Robinson, of Virginia, gave an insight into the demonstration work being done and needed in his State.

AFTERNOON SESSION, TUESDAY, AUGUST 17, 1909.

Vice-president G. A. Putnam called the meeting to order at 2 o'clock.

In the absence of W. J. Black, Winnipeg, Canada, Secretary Hamilton read his paper as follows:

THE PRACTICABILITY AND ADVISABILITY OF OPERATING STOCK AND PRODUCE "SALES FAIRS" AND PLAN FOR CONDUCTING THEM.

In considering the extent to which it would be practicable and advisable to operate stock and produce sales fairs, assistance may be had from a review of similar work carried on in Canada with much success during the past eight years. In the year 1901 the Ontario Department of Agriculture and the Dominion Cattle Breeders' Association held, at Guelph and Ottawa, Ontario, two sales of pure-bred live stock, which have been repeated annually since that time. At the earlier sales both cattle and swine were sold, but after two years' experience offerings consisted entirely of cattle, chiefly of the Shorthorn breed.

So satisfactory was this new method of disposing of pure-bred stock considered that associations of stock breeders in other provinces took it up, and every provincial live-stock association from the Atlantic to the Pacific in Canada now has given it a trial. In the provinces of Ontario, Manitoba, Saskatchewan, and Alberta sales are comparatively well established and are assisting in creating greater interest in the use of pure-bred breeding stock. Farmers come to these sales knowing that they will have the opportunity of purchasing pedigreed stock at a reasonable price. The breeder who operates on an extensive scale has an opportunity of disposing of his surplus, and the obscure stockman the privilege of offering his animals where buyers are led to congregate.

The live-stock associations under whose auspices these sales are held usually limit the number which may be offered for sale at any one point, and an effort is made to see that animals considered unfit for breeding purposes are not included in the catalogue. Usually sales are held in conjunction with, and at the conclusion of, a winter or spring fair; many of the best animals compete for prizes, and afterwards become the subjects of spirited bidding.

The only class of farm produce offered for sale at fairs in Canada has been seed grains. Thirty-seven years ago a farmers' club near Guelph, Ontario, held an exhibition at which grains were first judged and then offered for sale. So successful was this undertaking that to-day seed fairs are carried on, I believe, in every province of Canada. These fairs are held under the auspices of agricultural societies, and are directed by the provincial department of agriculture or the seed branch of the Dominion Government. In all cases the governments of the provinces give special aid financially to this work. In the grain-growing districts of the prairie country it is not unusual to have at a fair representing an area 30 miles in diameter, 30 exhibits of wheat, 20 of oats, 20 of barley, and a smaller number of peas, flax, timothy, and other seeds.

Usually the regulations insist that each exhibit contain not less than two bushels, and the owner is required to make a declaration stating that the sample shown is representative of at least 50 bushels offered for sale. Cards are attached to the exhibits, showing the name of the exhibitor, number of bushels for sale, and the selling price.

In the grain-growing districts of western Canada exhibitions of this kind have been carried on for five years with excellent results. In most cases addresses are delivered at the fairs by authorities on agriculture, and farmers have been led to realize the value of pure, clean seed. So great has the demand for selected seed become that well-established seed firms have been unable frequently to meet it, and progressive farmers are making a business of growing grain for exhibition, knowing that it can be sold at a higher price than may be obtained for grain not suitable for show. It is not uncommon for several thousand bushels of seed grain to change hands at a single fair.

Produce fairs therefore have been proven to be not only practicable but advisable in grain-growing districts, when confined to exhibits of seeds. Whether other classes of produce could be successfully included where these fairs are now carried on is a matter not yet settled. Since the seed of grains, the chief produce of one country, have been handled successfully at produce sales fairs, it seems reasonable to presume that the chief produce of other countries might be similarly exhibited and sold.

Rules and regulations for the government of seed fairs and live-stock sales are herewith appended for the benefit of those who may desire such information.

RULES FOR THE GOVERNMENT OF STOCK SHOWS AND SALES.

1. Animals whose pedigrees are published in the catalogue of sale may compete without any formal entry, but the committee reserves the right to order any animal out of the ring which, in its opinion, is not worthy of a prize.

2. The decision of the judge is to be absolutely final. There will be a class for males and females only of each recognized breed of cattle represented, and each class will be composed of the following sections: (1) Three-year-olds and over; (2) two-year-olds; and (3) yearlings. Championships in the various breeds will be given. A detailed prize list will be issued prior to date of the show.

3. The ages of cattle will be computed to the first of July.

4. In sections of three entries, one prize will be awarded; in sections of four entries, two prizes; and three prizes will be given if there are five or more entries. In case there should not be a sufficient number of entries in any one section to qualify for a prize, the various sections of the class may be amalgamated and prizes awarded on the above basis.

5. The sale superintendent appointed by the association will have entire charge of all animals on the grounds, stable accommodation and routine, and his instructions must be implicitly obeyed by all owners and attendants upon cattle.

6. A charge of 5 per cent on the amount realized by the sale of each animal will be retained by the association, in addition to the entry fee, to meet feeding, advertising, auctioneer, and other expenses.

7. Stock must be in the stable not later than 10 a. m. of the day prior to the date of sale.

8. All animals while on the grounds will be supplied with hay free of charge, owners finding their own grain. Grain can be generally purchased at reasonable prices on the grounds.

9. Prospective buyers will be given an opportunity of examining the stock prior to the sale.

10. Each animal entered shall be sold to the highest bidder. There shall be no by-bidding by the owner of the animal or anyone on his behalf. Statutory declaration may be required from any buyer or seller to the effect that any purchase or sale is bona fide, and that there has been no by-bidding in connection therewith.

11. The highest bidder will be the buyer, and if any dispute arises between two or more bidders, it shall be settled by the animal being again put up and resold. The decision of the auctioneer shall be final in all cases.

12. The privilege of withdrawing an animal from the sale at any time shall rest solely with the executive committee, and shall be exercised at the discretion of its duly appointed representative in the sale ring, and the executive committee shall have power to cancel the sale of any animal, before or after the delivery of such animal, provided such a course, in its opinion, is fair and just to both buyer and seller.

13. All purchases must be settled for within one-half hour of the sale of the animal. If purchasers fail to settle for their purchases as stated, the committee reserves full power to resell the animal to the best advantage, either publicly or privately, without further intimation, and any loss arising from resale, together with keep and all other expenses, will be collected from the defaulters at this sale.

14. Immediately after each purchase is declared, the risk of the animal shall be exclusively with the purchaser, and it is declared that until a settlement shall be made in the terms of these conditions the delivery of the animal shall be suspended.

15. Before an animal can be removed from the building the buyer must present to the superintendent an order signed by the manager, and give receipt for the animal. This order must be left with the superintendent, and will be evidence of the delivery of the stock. Owners and attendants are specially warned against surrendering animals sold without express order of the superintendent.

16. The manager will have power to give a receipt in full for all payments for stock, and will remit the amount realized less the proper charges, for each animal to the seller thereof, within three weeks after the date of the sale.

17. Animals not to be shipped by rail will be delivered to the buyers on the ground where the sale is held, and the buyers will take charge of them immediately after the close of the sale.

18. Contributors will be held responsible for any erroneous information respecting animals entered, that may appear in the printed catalogue of any association sale unless written notice of such error is filed with the manager prior to the commencement of such sale.

19. In the case of persons who wish to buy, but who can not attend the sale, or send a representative, if they forward their orders with full instructions to the secretary, he will be responsible for the prompt and honorable execution of such orders, and for the proper shipment of animals bought under this clause. In all such cases the money to be invested must accompany the order. If the order can not be filled in a manner satisfactory to the secretary, the money shall be refunded immediately.

20. Each animal offered must be a good representative of its breed, in good condition, in sound health, not defective, and shall be registered in a Canadian record recognized as reliable by the Dominion Department of Agriculture.

21. The following statement has been signed by every owner of stock entered for sale:

"I understand that all animals entered at the said public sale have proved to be sure stock getters if they have been tried. If they have not been tried, that the seller assumes no responsibility. I hereby enter the above-described animal subject to those rules, and believe that the said animal is a sure and reliable breeder."

RULES GOVERNING SEED FAIRS.

1. All grain entered for competition must have been grown by the exhibitor in the year ——.

2. No grain shall be allowed in competition for prizes unless the samples shown represent for sale as seed not less, in each class, than 50 bushels of wheat, 50 bushels of oats, 30 bushels of barley, 5 bushels of timothy, and 3 bushels of peas.

3. In each exhibit of wheat, oats, or barley not less than 1 bushel should be shown, and all exhibits shall be held to be representative of the whole quantity of such grain offered for sale as seed by the exhibitor

4. Exhibits containing such impurities as smut, weed seed, or other grains, which in the opinion of the judge are of a noxious nature, shall not be awarded prizes.

5. No exhibitor shall be allowed more than one entry in each section.

6. All exhibits of seed must be labeled after judging, giving the name and address of the exhibitor, name of the variety, amount for sale as seed, and the selling price.

7. Should a dispute arise, a statutory declaration that the above rules have been complied with may be required from any exhibitor.

8. All exhibits for prizes must be delivered at ———, ———, not later than —— o'clock — m., on ———, ———, and shall not be removed until the close of the fair.

9. Entry fees: Wheat and oats, 50 cents; other sections, 25 cents.

D. W. Working, Morgantown, W. Va., read a paper on the following subject:

What Plan Could be Adopted by the Institute for Securing the Introduction and Continued Maintenance the Entire Year of a Movable School in each State and Province?

The answer is not easily worked out to the satisfaction of anyone who knows the difficulty of introducing a new and unproved method. There are many difficulties in the way. Most of you know some of them. Happily for me, each of you know that no two problems are just alike; each of you know that my cut-and-dried plan will not work in your field.

I am assuming that there is and need be no conflict between the farmers' institute as such and the movable school as a school. I take it that the two institutions ought

to be kept very distinct; that neither is superior or inferior to the other; that, broadly speaking, both have the same purpose; that each has a permanent work to do; that the methods of the two should usually be very different; and, finally, that there should be real and purposeful harmony between the two.

Let me try to emphasize the suggestion that there is and need be no conflict between the institute and the movable school, and that there should be real and purposeful harmony between them. The farmers' institute is comparatively old and well established. I have suggested that it is a permanent institution. Individual men come to maturity and pass away; but the problems of life, of education, and of industry remain. Somehow, the institute appeals to men of all sorts and conditions. The institute is not a kindergarten school; it attempts to present the severely practical application of the facts and principles which most mature farmers know. Because the teaching process is long, and because it implies classification and gradation, the institute can not adopt the teaching process; and, usually, the man who has been well trained in the institute method, can not adapt himself to the teaching method. But the movable school should be a school, not a farmers' institute under a new and fetching name.

The younger men who are trying to organize the agricultural extension work with the school rather than the institute motive and method need to be warned—need to be saved. It is not particularly to our discredit that we know our work less certainly than the experienced institute superintendents and speakers know theirs. It may be that we never shall be quite sure of our field, our people, and our work. Some of us are more or less afraid, which may be good for us, and will be good for us if our fear leads us to study and to work and to adapt ourselves to the needs of the people we are trying to serve. And some of the institute men are afraid—which may be good for them, and will be good for them and all others concerned with their great work if their fear does not tempt them from the sure work which they know and have been doing with great acceptability, and lead them to attempt the sort of work upon which we are entering with so much uncertainty. We need to work in harmony, our work supplementing that of the institute men, theirs preparing the way for ours; and they need to understand that our work prepares for theirs even more than theirs prepares for ours. Always the school idea implies that instruction shall be more or less elementary in character; while the institute idea implies that men of experience shall talk to and with men of experience. It seems to me that a county or State with a good farmers' institute system ought to be a good place for the movable school; and it seems to me, also, that every successful movable school should leave the community a very much better place for the best kind of a farmers' institute

These considerations are especially pertinent for those who are connected with institute work in States where the institute and the newer agricultural extension work are under separate management. The agricultural colleges and the boards of agriculture are partners in a great work for the promotion of agriculture and agricultural education; they are not rivals. It is not the business of the right hand to oppose the work of the left, even though the two may be said to be opposed to each other. Each has its own work; and each does its best when it is supported by the other; and I am not sure but that these considerations are just as important for those who have charge of both institutes and movable schools. The school idea is not to be lost sight of in the work of organizing schools; and the institute idea must dominate the farmers' institute. I could mention some admirable and admirably conducted week-long institutes that were called schools. My own impression is that the only serious defect of these institutes was their name; but there must have been confusion in thinking before these institutes were planned under the name of schools.

The farmers' institute is one of the agencies by which the State promotes agriculture; the college of agriculture is another of the agencies by which the State promotes agriculture. When you think of both of them as parts of the machinery of the State, you see the absurdity of the little rivalries and jealousies that have hindered the work in a few States. As well might the prayer meeting of the church be jealous of the Sunday school meeting supported by the same church. Both are part of the same great organization; and their work is different because of differences in age and interest and purpose.

More important than the plan is the man. Farmers are like the rest of us; they like the people they like; and when they dislike a man they prefer not to receive instruction from him. Moreover, they do not have to tolerate the man they dislike; some of us do, and then think we are broader minded than our farmer friends. So I would emphasize in passing the vital importance of genuine interest in the men on the farms and real sympathy with their problems. Without these the most helpful relations can not be established. Our relations with some people can be almost purely profes-

sional; with most country people they must be personally agreeable in order to be at all helpful: hence the importance of personal adaptability. The "good mixer" may be what he is because of the possession of many different qualities or gifts. In the country we need most of all to be genuine. Then we need to have a vital interest in our people and their problems. Indeed, unless the people become in a very real sense our people and their problems our problems, we are fated to fail. Wise enthusiasm wins in the country.

The purpose and the plan of the movable school need to be carefully stated. At every institute it should be announced that movable schools are for those who want them; that they are in no sense in opposition to the institute; that certain conditions must be complied with to justify organizing such a school; and that the management of the movable school will not be exacting concerning local matters. We must expect to be missionaries in spirit as well as in fact. Somehow, we must make the people believe that we mean business and that we have something worth paying for.

It is so difficult in most farming communities to discover the best time in the year for a school that many who would gladly support the idea hesitate. They want to do as well as other communities have done or do nothing; and then we are so poorly equipped to teach the many subjects in which the country is interested that we can not meet ordinary reasonable requirements. Think of the problem of the organizer of a movable school! In many cases he must discover what the people want or need, when they can give the time most easily, and then discover that the busy men he needs are so tied up with work or special engagements that he can not command their services at the only time when he can get his people together.

The teacher in the movable school must be at the service of the movable school practically all of the time if the best work is to be accomplished. At present we are only finding ourselves. To plan well the superintendent of the movable school must have financial resources as well as men; and he needs to be free to come and go and to spend and refrain from spending. Moreover, he needs to be at liberty this year to make sure promises for next year—needs also to have the power to keep his promises in both letter and spirit.

And may I add that the work of the movable school must be made worth while in itself? If the motive is to get students for the college, that motive is unworthy as a chief motive. The movable school has its mission to those who can not or will not attend the short course at the college. Incidentally, it may and should promote both the farmers' institute and the agricultural college.

G. A. Putnam, Toronto, Canada, read the following paper:

The Practicability and Advisability of Holding Separate Institutes for Women and of Organizing Rural Women's Clubs.

It takes considerable assurance on my part to come before this association and present a paper upon women's institute work. I have come almost to believe that I have only the women with me in women's institute work. We had, up to three or four years ago, or we thought we had, good reasons for expecting that women's institutes would be established in many of the States. So far as I can learn women's institute work has not been supported by that aggressiveness on the part of institute superintendents that we looked for, and I hesitated to advise some of my women's institute workers in Ontario to make an effort to attend this convention. I believe, however, that the day will come when you will have a thriving subassociation in the women's institute.

There is no question in the minds of those who have observed the workings of the farmer's institutes as to the beneficial results of such work to the individual farmer and also to the community, and if for a moment you will compare the relative importance of men's work on the farm and women's responsibilities and work in the household, we must at once concede the advisibility of establishing clubs or institutes for the women.

The most important department of the farm is the homestead, the successful management of which is reflected in the success of the farming operations, as well as in the high standards of living in the home.

The highest efficiency in growing grain, dairying, sheep raising, poultry production, etc., is the sooner attained when we provide a means, an institute, through which the farmer may be instructed in up-to-date methods, and be given an opportunity to discuss results, practical experiences, and the application of underlying principles. With the greater variety of work and the greater responsibility resting upon the housewife, the mother, the cook, the teacher, and general manager of the home, she should be given at least equal opportunities with her husband and brother in securing the latest and best information bearing upon her work.

Why should the farmer be instructed in the selection and combination of foods for stock and no opportunity be given to the home maker for securing information upon the comparative value of foods for men? We have expended much time and money in experiment to find out the best kind of construction and equipment for the stable, the barn, the piggery, and the henhouse. Many books and periodicals are published in the interest of the farmers. Is it more important that good agricultural literature should be provided for the men than that the needs of the mother and children should be considered?

The farmer is constantly brought into contact with his fellow farmer and in addition has the institute. Why then should not the farmer's wife, whose life is often most monotonous, be given the advantages of the sociability of the institute, as well as the opportunity through the institute of getting information bearing directly upon the responsibilities which come to her from day to day?

Even though the practicability of women's institutes, or the rural clubs, had not been demonstrated, the arguments above presented should convince us of the advisability of making the experiment. Their practicability has already been demonstrated, and with your permission I shall present to you some essentials to success in women's institute work, also some of the results following such work.

It is unnecessary that I should present to you the methods of organization that have been placed before this association at former conventions. I think it was last year that I said to the members of this association that I would furnish them with copies of our rules and regulations. The supply is exhausted, but we shall be pleased to furnish copies of the new edition upon application.

If you are going to do effective work, if you are going to get people to do work on their own account, it will be necessary for you to have some sort of local organization; and we must, in order to get results, throw a good deal of responsibility upon local organizations.

We are time and time again met with the statement of those who are approached regarding institute work that there are no people living in the locality who would be willing to prepare papers or give addresses upon "home" subjects; but, with a little advice and suggestion on the part of lecturers and direct from the department, we find that fully 90 per cent of the organizations show in the course of the year, or less, that they are carrying on as effective work among the members as we can do by sending speakers to them. There is latent talent in every locality awaiting development, both among the farmers and the women of the town and country.

The local organizations make reports to the department of agriculture, thus putting us in a position to offer suggestions along the line of work which they are taking up. By knowing something of the line of work followed in each society the superintendent is in a position to give them helpful advice. We have arranged for cooperation between the local institutes and the domestic science department of the agricultural college at Guelph. We have announced to the institute that the officials of the domestic science department of the agricultural college will be prepared, not to furnish them with the papers, not to write out addresses for them, but to give them suggestions as to where they can find the best up-to-date literature upon whatever subject they think of taking up at their next meeting. Magazine articles and standard works are loaned to the institutes.

Then in women's institute work, probably to a greater extent than farmers' institute work, you must secure practical persons as lecturers—women who are capable, and who are acquainted with farming conditions, and who are in sympathy with the country people. An audience of country women will not listen to a lady who has had experience in the city only. Then, the city people, the townspeople, who we are glad to know are taking a great deal of interest in the work of women's institutes, find that they have a great deal to learn from the woman in the country who has to rely upon her own resources to a greater extent than the women in the town. The woman in the town, when she has a failure in her baking or cooking, is able to go to the corner grocery and get something to replace what is lacking, while the woman in the country is unable to do so. She has to rely upon her own resources. It is most gratifying to note the spirit of mutual helpfulness which exists among the town and country people. In the winter months in some localities the farmers' wives to the number of forty or fifty drive to the town in the afternoon and join with their town friends in holding a meeting. In the summer months the townspeople get two or three car or boat loads and go to the country to hold their meetings in the orchard or on the lawn of the farmer, and we find that the country people are learning a great deal from the townspeople and the townspeople are coming to know what thorough and competent providers and managers are to be found among the country ladies.

Now, for a few results of women's institute work. We find that the officers and members of women's institutes are the ones who are inquiring as to the facilities provided for the education of coming mothers.

In many localities the local jealousies which have existed for years have been eliminated by the women's institutes. The women meet in the institute to become thoroughly acquainted with their neighbors, upon whom they looked with more or less suspicion, but who prove to be true friends and neighbors. You know the country people are inclined to be jealous, but the institute is doing much to eliminate these petty jealousies. In one district in Ontario, which I had the pleasure of visiting not long since to meet institute officers and members, I was told that there were two factions in the locality up to a couple of years ago, when an institute was formed there. A lady who came there three years ago said that life in the district was made unpleasant by the rivalry of the two factions. Now everything is peaceable and people are looking at life from a broader view point, due almost entirely to the influence of the institute.

The women's institutes are not confining their work to matters concerning the home, but are giving some attention to work of a public character. They are going to the schools and inquiring into the sanitary conditions; are placing suitable water pails in the schools, are seeing that the schoolhouse is swept regularly, that the ventilation is as it should be, and are planting flowers about the school. In one locality where the town council did not see its way clear to build sidewalks and to set out trees the women's institute approached the council and made a proposition to get up an entertainment for the purpose of raising funds to buy cement and put down a sidewalk. Then they went to the farmers and arranged for the drawing of the gravel. Then they rode over to an adjoining town and secured an expert in putting down sidewalks to come and superintend the work. The farmers came and drew the gravel, the cement, and did other necessary work, with the result that a mile of splendid sidewalk was put down. In some places they have used their influence in having trees planted, street lights installed, and other work of a public nature done. Then we find the institutes cooperating in making the local libraries more useful to the community. They advise the library board as to the literature which will be of interest and value to the home maker and her children. The homes have periodicals and papers in larger numbers since the institute came and are making an intelligent use of the articles that appear in the bulletins and periodicals.

An increased sociability among the country people has been created. We believe that the mothers and sisters who belong to the women's institute will do much to interest the boys in matters relating to agriculture. The mother has a great deal more influence upon the growing boy than the father has, and a suggestion or advice from her will often result in a boy taking an agricultural course rather than one of the other professions.

We encourage the officers of the women's institute to give a day occasionally to the girls, inviting them to take some part in the proceedings—contributing music, reading a paper, or exhibiting something which they have made. With the cooperation and sympathy of the young we are assured of the permanency of the organization.

Much has already been done through the women's institutes of Ontario toward the betterment of home and community conditions, and the large body of officers and members (about 14,000) are confident that greater successes are in store for this growing organization. We have an enthusiastic, capable lot of women belonging to nearly every one of the 520 branches, and the words of appreciation of the work being done and the enthusiasm which marks the efforts of the officers bespeak continued success and added advantages and benefits to the rural population.

L. A. Merrill, Salt Lake City, Utah, then read the following paper:

What Form of Organization Would be Best Adapted for Women's Institutes and Rural Clubs for Women and How Should the Expenses of Such Clubs be Met?

Limitations and difficulties.—Before discussing the topic assigned me, it will be necessary to enumerate the difficulties to be met in the organization of women's institutes, and, if possible, to find some means of eradicating these difficulties. No class of people in the world to-day is so eager for improvement and yet so difficult to reach with the desired improvement as is woman. She has just been aroused from the long sleep of the ages into the realization of the fact that her work is important and at the same time needs improvement; yet through lack of experience she hardly knows how to go to work to attain the desired end. In the first place, her supposed difficulties seem to make any improvement impossible. Women are usually burdened

with home ties, directly or indirectly, and they feel that it is impossible ever to leave home for any purpose other than occasional pleasure or business. Here is a chance to let her feel that it is imperative for her to better her own conditions, that the family who are more or less dependent upon her may indirectly receive the benefits she receives. If this thought could be clearly brought home to the women of the country the first step toward making these rural clubs more general for women would have been taken.

Another difficulty to be met is the fact that woman is oftentimes indifferent to home surroundings. Probably, rather than being indifferent, she is too conservative. She feels that what she has done during all the years of her life and what her mother and grandmother did before has given pretty good results and she ought to be satisfied with them, and the knowledge that there is something better in the world for womankind to-day is vague and she hasn't the desire to understand its full significance. This attitude is partly due to the fact that women were trained in their life work altogether at mother's elbow and nearly always with the feeling that housework is drudgery. Mother's methods may have been good or bad, according to circumstances. The girl is imbued with the idea that housework is a thing to be gotten rid of as quickly as possible, and many women have the idea that if it could be avoided entirely woman's life would be a happier one. The work of the rural clubs for women is concerned more with eradicating this point of view than with any other phase of the subject. The more advanced women are handicapped also by the feeling that housework is hard enough, and if they ever do get a chance to leave home ties for an afternoon's discussion or meeting, they want some other topic to talk or think upon, their excuse being that they have enough housework; when they leave home they want a change; they do not want more housework, but less of it. Woman's general indifference and her lack of training cause this failure to perceive that greater intelligence and more training lightens home duties, and the more that she can learn about household economics, the better able will she be to make her home work contain less drudgery, at the same time allowing her more time for the mental pursuits or artistic accomplishments that may attract her.

Organization.—How shall women's institutes and rural clubs for women be organized is the second point in the discussion to-day. . In the first place, we will discuss their organization as individual clubs. Each town possesses a few public-spirited ladies who may have had a taste of some phase of home training, and may possess sufficient enthusiasm to organize themselves into a separate club for the study of problems concerning home making and the best methods of performing the daily work of the home. These women should be in constant communication with the state board of farmers' and women's institutes, so that their course of study may be outlined for them, their work made systematic, and that they may be directed toward the discussion of the subjects that have most value in solving their individual home problems. The details of such individual organizations will have to be arranged by the club members themselves. Afternoon meetings will be more convenient in some localities, evening meetings in others. In some communities it will be found that these same public-spirited ladies have already organized themselves into literary or social clubs. In such localities the state board will find the greatest difficulty in persuading the women that they need another organization. These ladies usually feel that one organization is enough; that all their energies and time spared from home duties are required in the club already organized. Under such conditions the leaders must be made to understand the value of this great work, and persuaded to devote one meeting or more out of the month to subjects concerning the improvement of home conditions or the simplifying of home duties. State boards should never refrain from making these ladies feel the responsibility they owe to less favored women in pointing out the way to better home conditions. If it is found impracticable to hold separate club meetings, it may be possible in communities where there are already organized farmers' clubs to hold joint meetings. There are many points in favor of these joint farmers' and women's meetings. The men and women may find it more convenient to attend the meeting together, and it may also be profitable to render a joint opening program, in which short discussions of topics of mutual interest to farmers and farm wives may be discussed. Then, after this short opening program, each may adjourn to separate rooms for separate discussion of the evening's work.

It is a truism, but a fact nevertheless, that woman is the power behind the throne. If women are interested in the work of the farm and the farm home, all kinds of improvement will be made easier. If men become awakened to the fact that the farm home needs improving as well as the farm, the life led by the women will be much easier and more pleasant for the entire farm family. Another reason why we recommend these joint meetings is the fact that in all life, especially farm life, men and women

should be yoked equally; not one pulling for improvement and the other pulling back, but each working shoulder to shoulder for the bringing about of the best possible results for the greatest common good in their conditions. Then will the subjects of home and the farm take their places, and indeed then will it be possible to understand that home improvement should come first. As a matter of fact, if the women of the country could be converted to the fact that happiness and a certain amount of ease and all the freedom in God's universe could be obtained by living on a well-kept farm, all the trouble about keeping boys on the farm would be at an end.

In a word, women hold the key to the situation. They can turn it which way they will. It remains for us who are interested in this movement for farmers' organizations to use every means within reach to make the women of the country realize the beauties, the joy, the freedom from restraint and the all-sided development possible in farm life. This understanding is more possible where the farmers' and women's clubs meet jointly.

How can farmers' organizations reach the isolated farm home? It is rather difficult to discuss this topic properly, because of the fact that Utah has very few isolated farms. The pioneers of Utah created the precedent of farmers living together in a village community with their farms scattered around the village. This was at that time necessary in our State for greater protection from Indians, and it was conceded to be conducive to greater social and educational opportunities for the young people of the farm. Wisely or unwisely, this custom has been strictly adhered to in the years following pioneer conditions. However, it may be suggested that the state farmers' institute board, by means of circular letters or printed outlines, may make the isolated women feel that they are still a part of the great world, and that they, too, have a chance to improve and progress, even though the circumstances may be against them. The woman on the isolated farm should be advised to increase her store of knowledge by means of books on the subject of home making, magazines on home subjects, and by having her name on the mailing list of the United States Department of Agriculture and the various experiment stations, thereby receiving all bulletins that may be printed with reference to her work. In States where there are many of these isolated farms it would be worth while for the state board to take steps toward the establishment of state traveling libraries on home economic subjects. A little package of books may be made up that could be passed from home to home, the supervision of which could be in the hands of a state librarian appointed for the purpose.

There is another means of interesting the isolated farm housekeeper which is rather difficult of discussion because of lack of experience in Utah, namely, the grange. It should be mentioned here because of the great work accomplished in some States by these granges. They seem especially to assist the home that is apart from village or community life.

Organization as limited by sectional conditions.—We have already discussed to some extent the conditions existing in places where strong literary or social clubs are organized. Other communities are very thoroughly organized through their churches. In Utah, for instance, the predominant church has organizations comprising the little tots from six years of age, of both sexes, until maturity. These organizations are indirectly spiritual in their nature, but more directly for mutual improvement or for the real improvement of home life. In communities where these strong organizations exist, we have found it very advisable to allow the existing organizations to be the local managers of any institutes or farmers' schools we wish to hold; and while the institutes are and must be always nonsectarian in their nature, still there is no objection to using every means within reach to encourage people already engaged in improving home conditions to take up the work of the farmers' and women's institutes. We have found it advisable to enlist the sympathy of every individual in every community wherever possible, irrespective of class and creed. We stand for home improvement and we welcome any aid which will bring that about. In communities which lack all kinds of women's organizations may be found a chance for vigorous work by the state boards. Here women must be encouraged; they must be kept posted concerning the work that is being done at the agricultural colleges; they must be written to, and by every possible means encouraged to get into line with their brothers and, if necessary, lead the way and show the good results that follow the organization of these rural clubs. Every means must be tried for making these women enthusiastic on the subject of home economics.

Women's institutes.—We feel very strongly the importance of women's institutes. Some sections of the country have had much experience in the holding of women's institutes; others have never tried it. I think we come in somewhere between the two extremes, having introduced women's institutes within two years after the farmers' institutes were organized. We feel very keenly the importance of these institutes,

and wish we might urge those communities which are still behind in the matter of holding them to catch up as quickly as possible, because the good that results from women's activity can scarcely be estimated.

Women seldom hold direct power. The indirect power they exercise is very great. Get a woman converted to the fact that the boy must be sent to the agricultural college so that he may begin life with the experience with which his father ended it; open her eyes to the fact that the girl may learn the duties of the home in a more complete and perfect manner than by doing them by rote at her elbow, and the agricultural colleges and home economic schools will be filled to overflowing. Women should be in the van of improvement instead of following at the rear. She it is who influences in a large measure the boys and girls who are born and reared in the home.

As to the methods of holding these women's institutes, it may not be amiss to give in brief the plans followed in Utah. Wherever farmers' schools or institutes are planned, arrangements are made for holding sessions for the women, each afternoon and evening. The professor of domestic science at the agricultural college, or one of her assistants, is always present to lead in the discussion. If several sessions are held, there is a demonstration on bread making, cooking of meats, salads, etc. After a brief lecture and a demonstration, a discussion always follows, bringing out the experience of the most successful home makers. These discussions are very interesting, and often extend beyond the hour for adjournment.

Recommendations.—We have found it advisable after ten years of experience in holding joint women's and farmers' institutes to hold at least one joint meeting daily during the session and one separate meeting. There are many topics that men and women should be equally interested in, such as home sanitation and the improvement of grounds and outhouses from a sanitary point of view; other subjects connected with dietetics are of equal importance to women as well as to men. Then, too, there are subjects which the farmers discuss that if understood by woman would make her more truly a helpmate to the man. So, for these joint meetings we try to arrange a program that will be equally helpful and instructive to men and women. Then, we have one separate meeting in which the more technical subjects are discussed. In arranging the program for these meetings we always consider local talent and give it a chance to appear on the program, allowing always ample time for discussion. It is never advisable, especially in dealing with people who may lack technical training, to crowd the program. It is best to discuss one subject and make it clearly understood by even the dullest person present and leave the other good subjects to a future meeting, rather than to crowd the mind of the untrained listener until she goes home with the feeling that she has listened to some nice mental hash which is all impracticable and wasn't meant for her anyway. This is the mistake too often made in the program of the farmers' institutes.

We urge as often as possible the publication of bulletins on the subject of better home conditions, giving the results of what station workers or home economic workers or workers of the state board of farmers' and women's institutes may be doing toward the solution of problems confronting the home makers to-day. These bulletins should be of a popular nature to appeal to those who have not had the advantage of technical training in their life work.

Expenses.—We have seemingly left a very important half of this paper a minor part of the time. We suggest that it is possible for individual clubs, where they exist, to have things pretty much their own way if they manage their expenses as they do in individual literary or social clubs. Each member should be required to pay a certain initiation fee with a yearly due, which, if wisely spent, will enable the club to pay the expenses of one of the state board of women's clubs to visit them once a year to talk on subjects that the club may specify. Where the women are determined, the expenses need not figure largely, except in places that are remote from railroads or from the state institutions. These communities are often more straitened in circumstances, ready money is harder to find, and in such cases the organizations will be more or less dependent upon the arrangements made by the state board of women's and farmers' institutes. In clubs where women are cooperating with men, the expenses of special lecturers may be met in much the same way as indicated for the individual clubs; but in general, it will be found that the receipts from the farmers' schools offered by the state board will provide for the necessary expenses.

In Utah the law provides that a separate institute must be held in each county each year. The towns in which the institutes are held may be varied from year to year, and individuals living in other parts of the county must make the effort of the year to attend the meeting in whichever town they may be held.

DISCUSSION.

Miss Jennie Buell, of Ann Arbor, Mich., spoke of the good results being obtained by the women's institute in Michigan, and advocated its extension for the uplifting of the farm home.

Mr. D. W. Working, of West Virginia, pointed out some difficulties he had encountered.

R. A. Pearson, of New York, advocated using both men and women lecturers for institutes for either men or women.

W. L. Amoss, of Maryland, said the movable schools were encouraging the formation of women's institutes.

FIVE-MINUTE REPORTS FROM THE CANADIAN PROVINCES.[a]

ALBERTA. By H. A. Craig, Edmonton.

In 1906 the department operated a traveling stock-judging school. Good specimens of the popular breeds of live stock were secured from breeders and were shipped from place to place throughout the Province. These were used in specially fitted class rooms for demonstration purposes. During last season this scheme was again put into operation with some improvements. The great difficulty experienced during the first tour was to secure a suitable building to use as a class room; to get it properly heated, lighted, and seated was a difficult task. This year the department purchased a round tent 50 feet in diameter to use as a class room. It was fitted up with stoves and sufficient portable circus seats to accommodate 300 people. The outfit was so constructed as to make it quite easily shipped from place to place with the stock. Three days were spent at each of 12 towns. There were 5 men on the staff and 5 helpers.

During the year the department inaugurated a two weeks' short course in agriculture. The following subjects were dealt with: Noxious weeds, stock judging, grain judging, stock breeding, poultry, dairying, horticulture, soil cultivation, and forestry. The board of trade in the town where the course was held guaranteed single fare to all those who wished to attend the course. This reduced the cost quite materially to those who came from a distance. The stock which was used at the above-mentioned school was also used in connection with this short course.

BRITISH COLUMBIA. By H. W. Hodson, Victoria.

See statistical table.

MANITOBA. By W. J. Black, Winnipeg.

See statistical table.

NOVA SCOTIA. By F. L. Fuller, Truro.

Owing to the prevalence of diversified occupations it has been rather difficult to conduct institutes in the same manner as is done in Ontario or as in the United States. Our agricultural organizations consist of agricultural societies. These societies receive government aid pro rata for the amount subscribed, which at the present time amounts to nearly 100 per cent of the amount they subscribe. The funds of such societies are devoted largely to the purchase and importation of pure-bred live stock. This stock is purchased subject to inspection and approval. While such societies are encouraged to hold meetings for the purpose of discussing subjects bearing on agriculture, they are only compelled to hold one meeting annually.

In addition to this we have a provincial association, which is composed of delegates from agricultural societies and other agricultural organizations in the Province. This meets annually and usually lasts three days, holding five to six sessions. There are also county and district associations. These receive government aid, but the funds are devoted to the holding of institute meetings in a manner similar to your regular institute.

[a] Reports on the institute work in the United States are not given here, because the more important data regarding this work are embodied in the annual report of the Farmers' Institute Specialist of the Office of Experiment Stations and in the statistical summary on pages 50 and 51.

ONTARIO. By George A. Putnam, Toronto.

The season of 1908-9 was one of great activity in the institute work of Ontario. While the interest in the regular institute work was well maintained and much good work done along practical lines, the chief features were an increase in the extent of and interest in women's institute work, the holding of special institutes or short courses, and the organization of local farmers' clubs.

The women's institutes of Ontario are to be found in 91 electoral districts, with a separate organization at 530 places, a membership of over 14,000, and a total attendance for the year of considerably over 105,000. The women of the country have demonstrated their capabilities for planning and carrying on work which can not but result in much benefit to the home and community life of the districts concerned. For the most part, practical subjects bearing directly upon home management and training receive their attention. In addition to the regular monthly meetings addressed by local members, we sent out from the department to one or two meetings at each place during the year persons who have been specially trained along domestic science, dairying, poultry, or some other line of interest to the women on the farm. It is generally admitted that in those districts where such work has been carried on for several years, there is a noticeable improvement in the home life, and a community spirit has been fostered. An increased pride in the surroundings of the home both indoors and surrounding the homestead, is a result largely of the women's institutes. The women have done something toward civic improvement, and are showing their interest in sanitation and ventilation in the public building—the school, the hall, and the church. There is greater indication than ever that women's institutes will be a prominent force toward improving social and economic conditions in the farm homes.

The department has encouraged the holding of short courses in stock and seed judging, fruit growing, and poultry raising. The farmers fully appreciate work of this nature and the demand for an extension of the short courses will be a natural outcome of the present situation.

We fully expect to see a slight decrease in the number of regular institute meetings held, but a decided increase in the number of special institutes for a special purpose. The aim is to take up some one line of work at these special institutes and short courses, and deal with it in a thorough and exhaustive manner, not only by giving lectures but by demonstration work wherever it is possible.

We believe that the most promising feature in connection with Ontario institute work is the possibilities surrounding the work of local organizations. We have already established about one hundred farmers' institute clubs, and with the good work accomplished, and judging from the appreciation shown by the farmers in the localities concerned, there will be a large extension in this line during the coming season. Much benefit can be derived by the average farmer by a discussion of underlying principles and exchange of experiences with his fellow farmers. A little encouragement from the department by way of sending speakers to address the clubs occasionally and some direction as to methods of carrying on the work will, we believe, have as great an influence in advancing the agricultural interests as any other form of educational work. The department undertakes to give advice occasionally to the officers of the club as to methods of work which may be undertaken with profit. Altogether we are hopeful for the future of the farmers' institute work in Ontario. No doubt some changes will be introduced from time to time, but the good results already attained and the possibilities for the future bespeak a permanency for this line of agricultural education.

QUEBEC. By G. A. Gigault, Quebec.

See statistical table.

SASKATCHEWAN. By John Bracken, Regina.

We have inaugurated no particularly new work, but have endeavored to develop all the old lines of carrying information to farmers. The institute work, seed-grain fairs, grain-field competitions, grain shows, plowing matches, experimental-farm excursions, and short courses, have been conducted very much as usual, except that the details of each have been improved and made more workable. These improvements and added zeal have resulted in a particularly successful year in institute work.

We have under consideration some new lines of extension work. We are preparing a more extensive "agricultural-extension" campaign, but full details are not yet arranged. Another year we shall have more to say regarding this new work contemplated.

ELECTION OF OFFICERS.

A nominating committee consisting of E. A. Burnett, of Nebraska; Franklin Dye, of New Jersey; G. A. Gigault, of Quebec; W. T. Clarke, of California; and J. Withycombe, of Oregon, nominated, and the convention elected, officers of the association for the ensuing year as given on page 6.

REPORT OF THE TREASURER.

Account of John Hamilton, treasurer of the American Association of Farmers' Institute Workers, from November 3, 1908, to August 16, 1909.

Dr.

To balance in hands of the treasurer, November 3, 1908	$530.08
To receipts from 45 States and Provinces	225.00
To receipts from individual membership dues	43.00
To interest on deposits	5.79
	803.87

Cr.

By amount paid for printing 3,000 programs	23.25
By postage	31.50
By amount paid for printing letter heads	3.75
By balance in the hands of the treasurer August 16, 1909	745.37
	803.87

REPORT OF AUDITING COMMITTEE.

The undersigned committee, appointed to audit the accounts of John Hamilton, treasurer of the American Association of Farmers' Institute Workers, report that they have examined the accounts and have compared his vouchers with the credits claimed and have found the same correct, and the balance in his hands August 16, 1909, to be seven hundred and forty-five dollars and thirty-seven cents ($745.37).

(Signed) Wm. L. Amoss,
Andrew S. Elliott,
Committee.

REPORT OF COMMITTEE ON PRESIDENT'S ADDRESS.

In the address of President Ellsworth we have an able, conservative paper, characteristic of the man. We request the secretary of this association to secure its publication in full if possible.

When we consider the fact that we can not adopt any rule for the organization and method of conducting the farmers' institute work that will apply in all the States and Provinces, but that each locality must adopt methods best adapted to itself, we find in the address little to criticise and much to commend.

In this report we desire to call your attention to the following points which we believe deserve emphasis:

(1) That the local people should be consulted as far as possible in preparing the program, and they should furnish some financial aid to the meeting by way of providing a hall properly warmed and lighted, and some local speakers if good ones can be obtained.

(2) The man in charge of the work who represents his State should be one who understands farm problems and is in hearty sympathy with those in need of help.

(3) The welfare of the farmers' institute demands that the work shall be entirely divorced from party politics.

(4) Demonstration work should be encouraged as far as possible, carrying it to the home, stable, or field whenever it can be done.

(5) We heartily commend that portion of the president's address in which he emphasizes the importance of having the farmers' institute as a distinct educational agency, in so far as it applies to the older and wealthier agricultural States, but believe in the newer and less densely populated States the work can best be done under the direction of the various state agricultural colleges.

D. P. Witter,
O. M. Olson,
Lewis A. Merrill,
Committee.

REPORT OF THE EXECUTIVE COMMITTEE, 1908-9.

The executive committee met immediately upon the adjournment of the association, November 17, 1908, and organized by the election of A. M. Soule, Athens, Ga., chairman.

The following appointments were made for the several standing committees, their terms expiring in 1911:

Institute organization and methods, J. H. Connell, Stillwater, Okla.; institute lecturers, B. Walker McKeen, Fryeburg, Me.; cooperation with other educational agencies, G. C. Creelman, Guelph, Ontario; movable schools of agriculture, L. R. Taft, East Lansing, Mich.; boys' and girls' institutes, F. H. Rankin, Urbana, Ill.; women's institutes, Miss Martha Van Rensselaer, Ithaca, N. Y.

No other regular meeting of the executive committee was held during the year, but the time and place of the next meeting of the association was fixed by correspondence. Inasmuch as some difference of opinion existed in the committee respecting these points the entire question was submitted by the secretary at the direction of the committee to the state directors of farmers' institutes. The result of the vote was a declaration by a majority in favor of Portland, Oreg., the date to be August 16 and 17, 1909, immediately preceding the dates set for the meeting of the Association of American Agricultural Colleges and Experiment Stations.

The program for the meeting was prepared by the secretary and submitted to the members of the executive committee for criticism and suggestions. Three thousand copies of the program were printed and 2,500 copies were distributed. In addition to the distribution of the program 5,000 copies of notices of the time and place of the meeting were sent out to the institute workers of the United States and Canada and to about 500 agricultural newspapers.

Five thousand copies of the report of the proceedings of the meeting held in Washington, D. C., November 16 and 17, 1908, were printed and distributed among the institute workers of the United States and Canada.

The report of the treasurer shows receipts from 45 States and Provinces amounting to $225, and from individual membership dues $43. This is a considerable increase over the number of States and Provinces contributing previously to the institute fund, and represents also a larger number of individual membership fees.

Respectfully submitted.

A. M. Soule,
H. T. French,
F. H. Hall,
J. L. Ellsworth,
John Hamilton,
Committee.

REPORT OF COMMITTEE ON RESOLUTIONS.

Approval was expressed of the action of the Association of American Agricultural Colleges and Experiment Stations in favor of extension teaching in agriculture; and it was suggested that the executive committee plan to hold future meetings at the same time and place at which that association holds its meetings.

The work for women and for boys and girls was approved, as well as that of all agencies striving for progress in agricultural education and practice.

REPORT OF THE FARMERS' INSTITUTE SPECIALIST OF THE UNITED STATES DEPARTMENT OF AGRICULTURE FOR THE YEAR ENDED JUNE 30, 1909.

By John Hamilton, Washington, D. C.

Total number of sessions of institutes held in 44 States and Territories reporting	13,496
Total attendance at regular institutes in 44 States and Territories reporting	1,715,353
Attendance at special institute meetings in 41 States reporting	576,445
Attendance upon railroad specials in 12 States reporting	155,274
Total attendance as above	2,447,072
Appropriation to institutes, 44 States and Territories reporting	$308,122.74
Cost of institutes in 44 States and Territories reporting	$302,622.11
Average cost of the institutes per session in 44 States and Territories reporting	$22.42

No institutes were held in Louisiana, Nevada, and Alaska.

STATISTICS OF FARMERS' INSTITUTES IN THE SEVERAL STATES, TERRITORIES, AND PROVINCES, 1909.

State, Territory, or Province.	Regular institutes.			Round-up institutes.			Normal institutes.		
	Sessions.	Attendance	Average.	Sessions.	Attendance.	Average.	Sessions.	Attendance.	Average.
Alabama	42	4,240	101	45	597	13			
Alberta	185	8,325	45				2	42	21
Arizona	34	1,862	55						
Arkansas	70	46,161	659						
British Columbia	284	8,661	30	5	160	32			
California	297	28,294	95	8	2,928	366			
Colorado	130	17,160	132						
Delaware	70	9,210	131						
Florida	54	5,576	103						
Georgia	56	4,480	80	15	600	40	[a] 60	[a] 2,400	[a] 40
Idaho	68	3,400	50						
Indiana	1,162	215,211	185						
Iowa	415	103,750	250						
Kansas	576	37,191	64						
Kentucky	464	21,578	46						
Maine	79	8,267	104						
Manitoba	133	7,302	55	27	1,014	37			
Maryland	97	9,345	96						
Massachusetts	187	20,765	111						
Michigan	1,151	157,438	137	12	10,125	844	7	175	25
Mississippi	166	25,229	152						
Montana	119	10,961	92						
Nebraska	500	86,623	173						
New Jersey	128	10,425	81	7	2,200	314			
New Mexico	50	1,696	34						
New York	1,020	133,787	131	[b] 33	[b] 21,815	[b] 220	11	330	30
North Dakota	281	46,538	165						
Nova Scotia	[c] 161	[c] 10,518	[c] 65	[d] 6	[d] 960	[d] 160			
Ohio	1,760	440,000	250	5	500	100	2	80	40
Ontario	5,800	215,000	37				4	2,050	512
Oregon	79	16,930	214						
Pennsylvania	982	156,652	159				9	1,800	200
Quebec	376	37,752	100				90	5,850	65
Rhode Island	9	1,000	111	3	500	166			
Saskatchewan	215	13,330	62				16	1,280	80
South Carolina	20	5,848	292						
Utah	218	18,089	83						
Washington	238	15,465	65	3	116	39			
West Virginia	356	19,424	54						
Wisconsin	694	89,587	129	11	3,503	318			
Wyoming	71	4,403	62						
Total	18,797	2,077,473	110	180	45,018	250	201	14,007	70

[a] Teachers' institutes.
[b] Institute schools.
[c] County associations.
[d] Provincial associations.

Statistics of farmers' institutes in the several States, Territories, and Provinces, 1909—Continued.

State, Territory, or Province.	Independent institutes.			Institute trains.			Picnics, harvest-home meetings, etc.		State lecturers.	Cost.
	Sessions.	Attendance.	Average.	Days.	Stops.	Attendance.	Number.	Attendance.		
Alabama									15	$1,200.00
Alberta	130	1,950	150	55	12	5,400	316	15,746	15	10,600.00
Arizona									4	123.95
Arkansas									3	2,135.00
British Columbia									36	7,047.41
California				64	197	37,270	1	2,000	25	7,000.00
Colorado				6	23	1,925			77	
Delaware									16	900.00
Florida									10	2,000.00
Georgia	32	2,400	75						16	7,000.00
Idaho	6	300	50	25	32	4,150	4		8	1,500.00
Indiana									45	19,000.00
Iowa										10,050.00
Kansas				6	72	6,304	30	6,768	30	8,200.00
Kentucky									15	10,653.14
Maine	7	640	91						12	2,500.00
Manitoba									20	83,702.76
Maryland				13	27	1,660			5	6,000.00
Massachusetts							2	600	64	2,153.14
Michigan				11	65	7,485			40	8,823.62
Mississippi				21	69	11,445			21	3,000.00
Montana				12	10	2,000			30	8,000.00
Nebraska	10								18	14,795.84
New Jersey				3	19	1,500			9	3,000.00
New Mexico							2	1,000	3	1,700.00
New York	[a] 12	[a] 16,517	[b] 150	2					53	28,000.00
North Dakota							12		4	9,835.22
Nova Scotia									22	
Ohio	400	100,000	250	7	65	10,000			52	22,000.00
Ontario	[c] 500	[c] 29,196	[c] 206				19	5,500	114	32,152.12
Oregon				11	41	40,730	3	1,400	6	2,946.65
Pennsylvania	30	29,160	972						73	20,000.00
Quebec									11	7,000.00
Rhode Island									15	187.29
Saskatchewan	125	6,250	50				12	8,000	25	5,500.00
South Carolina									8	516.26
Utah				56	48	16,658			15	2,825.11
Washington				26	103	28,990	4	591	23	5,000.00
West Virginia	28			6	27				18	9,249.29
Wisconsin									50	20,000.00
Wyoming									12	1,633.00
Total	1,280	186,413	145	324	810	175,517	405	41,605	1,038	387,929.80

[a] Cooperative institutes. [b] Average per hour. [c] Special institutes.

INDEX OF NAMES.

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON FARMERS' INSTITUTES.

BULLETINS.

Bulletin No. 79. Farmers' Institutes: History and Status in the United States and Canada. By L. H. Bailey. Pp. 34. 1900.
Bulletin No. 110. Proceedings of the Sixth Annual Meeting of the American Association of Farmers' Institute Workers, held at Buffalo, N. Y., September 18 and 19, 1901. Edited by A. C. True, D. J. Crosby, and G. C. Creelman. Pp. 55.
Bulletin No. 120. Proceedings of the Seventh Annual Meeting of the American Association of Farmers' Institute Workers, held at Washington, D. C., June 24-26, 1902. Edited by A. C. True and D. J. Crosby for the Office of Experiment Stations, and G. C. Creelman for the Association. Pp. 119.
Bulletin No. 135. (Revised.) Legislation Relating to Farmers' Institutes in the United States. By John Hamilton, Farmers' Institute Specialist. Pp. 35. 1905.
Bulletin No. 138. Proceedings of the Eighth Annual Meeting of the American Association of Farmers' Institute Workers, held at Toronto, Ontario, June 23-26, 1903. Edited by W. H. Beal for the Office of Experiment Stations, and G. C. Creelman for the Association. Pp. 119.
Bulletin No. 154. Proceedings of the Ninth Annual Meeting of the American Association of Farmers' Institute Workers, held at St. Louis, Mo., October 18-20, 1904. Edited by W. H. Beal and John Hamilton for the Office of Experiment Stations, and G. C. Creelman for the Association. Pp. 91.
Bulletin No. 155. Agricultural Instruction for Adults in the British Empire. By John Hamilton. Pp. 96. 1905.
Bulletin No. 163. Agricultural Instruction for Adults in Continental Countries. By John Hamilton. Pp. 32. 1905.
Bulletin No. 165. Proceedings of the Tenth Annual Meeting of the American Association of Farmers' Institute Workers, held at Washington, D. C., November 9-11, 1905. Edited by W. H. Beal and John Hamilton for the Office of Experiment Stations, and G. C. Creelman for the Association. Pp. 94.
Bulletin No. 166. Course in Cheese Making for Movable Schools of Agriculture. By L. L. Van Slyke. Pp. 63. 1906.
Bulletin No. 174. History of Farmers' Institutes in the United States. By John Hamilton. Pp. 96. 1906.
Bulletin No. 178. Course in Fruit Growing for Movable Schools of Agriculture. By Samuel B. Green. Pp. 100. 1907.
Bulletin No. 182. Proceedings of the Eleventh Annual Meeting of the American Association of Farmers' Institute Workers, held at Baton Rouge, La., November 12-14, 1906. Edited by W. H. Beal for the Office of Experiment Stations, and John Hamilton for the Association. Pp. 90. 1907.
Bulletin No. 199. Proceedings of the Twelfth Annual Meeting of the American Association of Farmers' Institute Workers, held at Washington, D. C., October 23 and 24, 1907. Edited by W. H. Beal for the Office of Experiment Stations, and John Hamilton for the Association. Pp. 79.
Bulletin No. 200. Course in Cereal Foods and Their Preparation, for Movable Schools of Agriculture. By Margaret J. Mitchell. Pp. 78. 1908.
Bulletin No. 213. Proceedings of the Thirteenth Annual Meeting of the American Association of Farmers' Institute Workers, held at Washington, D. C., November 16-17, 1908. Edited by W. H. Beal for the Office of Experiment Stations, and John Hamilton for the Association. Pp. 73. 1909.

CIRCULARS.

Circular No. 51. (Revised.) List of State Directors of Farmers' Institutes and Farmers' Institute Lecturers of the United States. By John Hamilton. Pp. 14. 1909.
Circular No. 72. Report of Committee on Extension Work presented to the Association of American Agricultural Colleges and Experiment Stations at the convention held at Baton Rouge, La., November 14-16, 1906. Pp. 8.
Circular No. 75. Report of Committee on Extension Work to Association of American Agricultural Colleges and Experiment Stations, Lansing, Mich., May 28-30, 1907. Pp. 16. 1907.
Circular No. 79. Form of Organization for Movable Schools of Agriculture. By John Hamilton. Pp. 8. 1908.
Circular No. 85. Farmers' Institutes for Women. By John Hamilton. Pp. 16. 1909.

SEPARATES.

Farmers' Institutes in the United States. By Dick J. Crosby. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1902. Pp. 25.
Farmers' Institutes in the United States. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1903. Pp. 57.
Farmers' Institutes. By John Hamilton. Reprint from Yearbook, Department of Agriculture, 1903. Pp. 10.
Annual Report of Farmers' Institutes. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1904. Pp. 58.
Farmers' Institutes in the United States. By John Hamilton. Doc. No. 711. Pp. 20. A pamphlet prepared for distribution at the Louisiana Purchase Exposition.
Farmers' Institutes in the United States. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1905. Pp. 55.
Farmers' Institutes in the United States. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1906. Pp. 56.
Farmers' Institutes in the United States. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1907. Pp. 47.
Farmers' Institutes in the United States. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1908. Pp. 46.

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION.

NOTE.—Publications marked with an asterisk (*) are not available for distribution.

BULLETINS.

- *Bul. 36. Notes on Irrigation in Connecticut and New Jersey. By C. S. Phelps and E. B. Voorhees. Pp. 64.
- *Bul. 58. Water Rights on the Missouri River and its Tributaries. By Elwood Mead. Pp. 80.
- *Bul. 60. Abstract of Laws for Acquiring Titles to Water from the Missouri River and its Tributaries, with the Legal Forms in Use. Compiled by Elwood Mead. Pp. 77.
- Bul. 70. Water-right Problems of Bear River. By Clarence T. Johnston and Joseph A. Breckons. Pp. 40.
- *Bul. 73. Irrigation in the Rocky Mountain States. By J. C. Ulrich. Pp. 64.
- *Bul. 81. The Use of Water in Irrigation in Wyoming. By B. C. Buffum. Pp. 56.
- *Bul. 86. The Use of Water in Irrigation. Report of investigations made in 1899, under the supervision of Elwood Mead, Expert in Charge, and C. T. Johnston, assistant. Pp. 253.
- *Bul. 87. Irrigation in New Jersey. By Edward B. Voorhees. Pp. 40.
- *Bul. 90. Irrigation in Hawaii. By Walter Maxwell. Pp. 48.
- *Bul. 92. The Reservoir System of the Cache la Poudre Valley. By E. S. Nettleton. Pp. 48.
- *Bul. 96. Irrigation Laws of the Northwest Territories of Canada and of Wyoming, with Discussions by J. S. Dennis, Fred Bond, and J. M. Wilson. Pp. 90.
- *Bul. 100. Report of Irrigation Investigations in California, under the direction of Elwood Mead, assisted by William E. Smythe, Marsden Manson, J. M. Wilson, Charles D. Marx, Frank Soulé, C. E. Grunsky, Edward M. Boggs, and James D. Schuyler. Pp. 411.
- *Bul. 104. Report of Irrigation Investigations for 1900, under the supervision of Elwood Mead, Expert in Charge, and C. T. Johnston, assistant. Pp. 334. (Separates only.)
- *Bul. 105. Irrigation in the United States. Testimony of Elwood Mead, Irrigation Expert in Charge, before the United States Industrial Commission, June 11 and 12, 1901. Pp. 47.
- Bul. 108. Irrigation Practice Among Fruit Growers on the Pacific Coast. By E. J. Wickson. Pp. 54.
- *Bul. 113. Irrigation of Rice in the United States. By Frank Bond and George H. Keeney. Pp. 77.
- Bul. 118. Irrigation from Big Thompson River. By John E. Field. Pp. 75.
- *Bul. 119. Report of Irrigation Investigations for 1901, under the direction of Elwood Mead, Chief. Pp. 401. (Separates only.)
- Bul. 124. Report of Irrigation Investigations in Utah, under the direction of Elwood Mead, Chief, assisted by R. P. Teele, A. P. Stover, A. F. Doremus, J. D. Stannard, Frank Adams, and G. L. Swendsen. Pp. 330.
- *Bul. 130. Egyptian Irrigation. By Clarence T. Johnston. Pp. 100.
- *Bul. 131. Plans of Structures in Use on Irrigation Canals in the United States, from drawings exhibited by the Office of Experiment Stations at Paris, in 1900, and at Buffalo, in 1901, prepared under the direction of Elwood Mead, Chief. Pp. 51.
- *Bul. 133. Report of Irrigation Investigations for 1902, under the direction of Elwood Mead, Chief. Pp. 266.
- Bul. 134. Storage of Water on Cache la Poudre and Big Thompson Rivers. By C. E. Tait. Pp. 100.
- *Bul. 140. Acquirement of Water Rights in the Arkansas Valley, Colorado. By J. S. Greene. Pp. 83.
- *Bul. 144. Irrigation in Northern Italy—Part I. By Elwood Mead. Pp. 100.
- *Bul. 145. Preparing Land for Irrigation and Methods of Applying Water. Prepared under the direction of Elwood Mead, Chief. Pp. 84.
- *Bul. 146. Current Wheels: Their Use in Lifting Water for Irrigation. By Albert Eugene Wright. Pp. 38.
- *Bul. 148. Report on Irrigation Investigations in Humid Sections of the United States in 1903. Pp. 45.
- Bul. 157. Water Rights on Interstate Streams. By R. P. Teele and Elwood Mead. pp. 118. (Separates only.)
- *Bul. 158. Report on Irrigation and Drainage Investigations, 1904. Under the direction of Elwood Mead, Chief. Pp. 755. (Separates only.)
- Bul. 167. Irrigation in the North Atlantic States. By Aug. J. Bowie, jr. Pp. 50.
- Bul. 168. The State Engineer and His Relation to Irrigation. By R. P. Teele. Pp. 99.
- Bul. 172. Irrigation in Montana. By Samuel Fortier, assisted by A. P. Stover and J. S. Baker. Pp. 100.
- Bul. 177. Evaporation Losses in Irrigation and Water Requirements of Crops. By Samuel Fortier. Pp. 64.
- Bul. 179. Small Reservoirs in Wyoming, Montana, and South Dakota. By F. C. Herrmann. Pp. 100.
- Bul. 181. Mechanical Tests of Pumping Plants in California. By J. N. Le Conte. Pp. 72.
- Bul. 183. Mechanical Tests of Pumps and Pumping Plants Used for Irrigation and Drainage in Louisiana in 1905 and 1906. By W. B. Gregory. Pp. 72.
- Bul. 188. Irrigation in the Yakima Valley, Washington. By S. O. Jayne. Pp. 89.
- Bul. 190. Irrigation in Northern Italy—Part II. By Elwood Mead. Pp. 86.

[Continued on third page of cover.]

1263 Issued June 7, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN 226.

A. C. TRUE, Director.

IRRIGATION EXPERIMENTS AND INVESTIGATIONS IN WESTERN OREGON.

BY

A. P. STOVER,

In Charge of Irrigation Work in Oregon.

PREPARED UNDER THE DIRECTION OF

SAMUEL FORTIER,

Chief of Irrigation Investigations.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1910.

OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.
E. W. ALLEN, Assistant Director.

IRRIGATION INVESTIGATIONS.

SAMUEL FORTIER, Chief.
R. P. TEELE, Assistant Chief.

IRRIGATION ENGINEERS AND IRRIGATION MANAGERS.

A. P. STOVER, Irrigation Engineer, in charge of work in Oregon.
C. E. TAIT, Irrigation Engineer, in charge of work in Imperial Valley and Arizona.
FRANK ADAMS, Expert, in charge of work in California.
S. O. JAYNE, Irrigation Manager, in charge of work in Washington.
W. W. McLAUGHLIN, Irrigation Engineer, in charge of work in Utah.
P. E. FULLER, Irrigation Engineer, in charge of power investigations.
W. L. ROCKWELL, Irrigation Manager, in charge of work in Texas.
D. H. BARK, Irrigation Engineer, in charge of work in Idaho.
MILO B. WILLIAMS, Irrigation Engineer, in charge of work in humid sections.
V. M. CONE, Irrigation Engineer.
CHESTER A. HASKELL, Irrigation Engineer in charge of rice investigations.
FRED G. HARDEN, Scientific Assistant.
R. D. ROBERTSON, Scientific Assistant.
J. W. LONGSTRETH, Agent in charge of work in Kansas.

COLLABORATORS.

O. V. P. STOUT, University of Nebraska, in charge of work in Nebraska.
GORDON H. TRUE, University of Nevada, in charge of work in Nevada.
W. B. GREGORY, Tulane University of Louisiana, in charge of rice irrigation in Louisiana and Texas.
F. L. BIXBY, Agricultural College of New Mexico, in charge of work in New Mexico.

IRRIGATION FARMERS.

JOHN H. GORDON, R. G. HEMPHILL, W. H. LAUCK, R. E. MAHONEY, and JOHN KRALL, Jr.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., March 7, 1910.

Sir: I have the honor to transmit herewith a report of experiments in irrigation made by this Office in the Willamette Valley, Oregon. The experiments were made by A. P. Stover, under the direction of Samuel Fortier, chief of irrigation investigations, and have been in progress for some years, the results for the year 1907 being published as Circular 78 of this Office.

The Willamette Valley is peculiar in that it has a very heavy annual rainfall, but a very light summer rainfall, making the midsummer the season when crops do not grow. This valley has been settled for half a century and has been devoted chiefly to wheat growing, for which the climate is admirably adapted, but the long-continued growing of this one crop has brought the land into such condition that profitable crops of wheat are no longer produced, making a change necessary. But the growing season of the other crops extends through the summer drought, making irrigation necessary to their growth. The results reported by Mr. Stover show clearly both the necessity for irrigation and its feasibility. It is recommended that the report be published as Bulletin 226 of this Office.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

IRRIGATION EXPERIMENTS AND INVESTIGATIONS IN WESTERN OREGON.

INTRODUCTION.

The investigations dealt with in this report were undertaken for the purpose of determining the value of irrigation for increasing and insuring the productiveness of the agricultural lands of the Willamette Valley and other similar valleys of western Oregon.

Climatic conditions in this region for the greater part of the year are typically humid. During the summer months from June to September, however, there is practically no rainfall and almost truly arid conditions exist. Under the agricultural practice of the past this condition has been beneficial rather than otherwise. Extremely mild winters, early moist springs, and dry summers were ideal for the production of grain, which for more than fifty years has been the predominant industry of the region. No thought was given to the value of irrigation during the dry period because it was unnecessary. Grain was a remunerative crop, and every farm was given over to its production to the exclusion of all other crops. Fertile as were these soils in the beginning—and they were fertile or they could not have withstood the abuse they have received—they could stand the constant production of grain only so long and then they began to deteriorate in productiveness, slowly at first but rapidly in later years. Land that once yielded 50 and 60 bushels of wheat per acre now produces in many cases only 10 or 12 bushels per acre, and much of the land can no longer be made to produce at all. Raising wheat on a basis of 12 bushels per acre is not profitable, and as a result grain growing as an industry is being abandoned, and agriculture is being forced to undergo a radical change.

Diversified farming is taking the place of the one time single-crop system. In the production of the new crops new conditions are encountered. What were ideal conditions in the old grain-growing days in the matter of dry summers are far from ideal for the production of these other crops. Grain was ripe and ready for harvest before the dry weather of the summer period could damage the crop, but the crops now being raised—forage, root crops, vegetables, hops, and fruits, the growth of which extends well into and through the dry season—suffer from lack of moisture at the very time they should be making their best growth.

Up to the present time this condition has been met, or more properly evaded, by seeking out favored locations along the river and creek bottoms and other sections where the soil was naturally moist, and bringing these into cultivation to the new crops. Practically nothing is being done, however, with the vast area of grain land that each year is growing less productive, except that in a few of the more favored localities vetch and clover have been introduced and a partial system of crop rotation established. Such, therefore, is the agricultural problem confronting the Willamette Valley and other valleys of western Oregon.

To aid in the solution of this problem, the Office of Experiment Stations was requested in 1906 by the Portland Board of Trade to undertake an investigation of conditions in the Willamette Valley to determine the value and feasibility of irrigation as a means of furthering intensive agricultural development in the affected region. The investigations were begun in 1907 and have been continued through the seasons of 1908 and 1909. Two lines of investigation have been followed during this period: (1) The collection of information bearing upon the feasibility of irrigation in the region being studied, and including physical data relative to climatic condition, topography, water supply, soil and crop conditions. (2) The irrigation of various crops under actual field conditions to determine the value of irrigation in increasing yields, the best methods of preparing land and irrigating it, the proper time of application, and the various other practical questions that require solution in order to properly solve the main problem.

While the investigations have been confined largely to the Willamette Valley, and the experimental work entirely so, it was early recognized that the same conditions existed in the two other valleys of western Oregon, the Umpqua and the Rogue River valleys, and that these sections should be reported upon also. A study, therefore, has been made of conditions in these other valleys and the facts gathered will be presented, thus making this report one dealing with conditions in western Oregon in general rather than in the Willamette Valley alone.

PHYSICAL CHARACTERISTICS OF THE WILLAMETTE VALLEY.

LOCATION AND SIZE.

The Willamette Valley lies in the western part of Oregon, between the high Cascade Mountains on the east and the Coast Range on the west. Its southern boundary is the summit of the Calapooias, a spur range of the Cascades, and its northern boundary the Columbia River. The length of the valley north and south is approximately 150 miles, and its width from summit to summit varies from 50 to 75 miles. Including its mountainous areas, the approximate area

within the Willamette watershed is 8,000,000 acres. Of this considerably over one-half is timbered, mountainous area, the valley and foothill land proper approximating 3,000,000 acres.

STREAMS AND STREAM FLOW.

The dominant physical feature of the valley is its stream system. The Willamette River rises in the southeastern corner of the watershed in the junction of the Calapooias with the high Cascades. Flowing northerly it follows the trough of the valley and empties into the Columbia at the northern extremity of the valley. From the Cascade Range on the east many tributaries make their way toward the trunk stream. Among these are several of the larger streams of the State, such as the Middle Fork, the McKenzie, the Santiam, the Molalla, and the Clackamas. There are a number of tributaries from the Coast Range on the west, but the flow of these is neither so large nor so constant as that which comes from the high watershed of the Cascades. Among the principal streams entering the valley from the west are the Coast Fork, Marys River, Luckiamute, Yamhill, and Tualatin rivers. The discharge of some of these streams during 1906, 1907, and 1908 is given in the following table:

Discharge of Willamette River and its principal tributaries, 1906–1908.[a]

Name of stream and place and time of measurement.	Drainage area.	Discharge.				Run-off.	
		Maximum.	Minimum.	Mean.	Total.	Per square mile.	Depth.
	Square miles.	*Cubic feet per sec.*	*Cubic feet per sec.*	*Cubic feet per sec.*	*Acre-feet.*	*Cubic feet per sec.*	*Inches.*
Willamette River, Albany:							
1906	4,860	52,800	2,810	12,600	9,060,000	2.59	34.93
1907		182,000	2,580	16,600	11,900,000	3.41	45.80
1908		51,900	2,760	10,400	7,590,000	2.15	29.29
Middle Fork, Jasper:							
1906	1,450	16,400	800	4,020	2,900,000	2.77	37.49
1907		93,500	530	5,180	3,690,000	3.57	47.73
1908		19,500	880	3,370	2,450,000	2.32	31.62
Coast Fork, Goshen:							
1906	690	15,000	68	1,580	1,130,000	2.28	30.80
1907		27,700	93	2,160	1,550,000	3.13	42.08
1908		8,030	36	1,310	946,000	1.89	25.73
McKenzie, Springfield:							
1906	960	17,400	1,630	4,650	3,350,000	4.84	65.89
1907		37,900	1,630	5,450	3,910,000	5.67	76.34
1908		19,200	1,820	4,160	3,020,000	4.34	59.02
North Fork Santiam, Mehama, 1906	740	36,200	700	3,930	2,830,000	5.31	71.67
South Fork Santiam, Waterloo, 1906	640	36,900	192	3,510	2,520,000	5.18	73.78
Molalla, Molalla:							
1906	220	7,120	60	913	656,000	4.15	55.93
1907		9,800		1,010	721,000	4.58	61.44
1908		8,550		816	592,000	3.71	50.49
Clackamas, Barton:							
1906	800	25,100	818	3,730	2,690,000	4.66	62.91
1907		42,000	600	4,140	2,960,000	5.17	69.40
1908		32,500	600	3,050	2,210,000	3.81	51.89
Luckiamute, Suver:							
1906		7,450	37	1,090	784,000		
1907		9,450	36	1,040	746,000		
1908		8,050	44	768	558,000		

[a] U. S. Geol. Survey, Water Supply and Irrig. Papers Nos. 214 and 252.

Owing to the nature of the precipitation the streams have their heaviest discharge during the winter and spring months. As the summer flow of the streams has an important bearing upon the feasibility of irrigation, the relation of the summer flow to the total yearly flow for the years 1906, 1907, and 1908 is given in the following table:

Yearly discharge and summer discharge of streams in Willamette Valley, 1906–1908.

Name of stream and place of measurement.	Year.	Yearly discharge.	Discharge during July, August, and September.	
		Acre-feet.	*Acre-feet.*	*Per cent.*
Willamette, Albany	1906	9,060,000	747,000	8
Do	1907	11,900,000	658,000	5
Do	1908	7,590,000	770,000	10
Middle Fork	1906	2,900,000	215,600	7
Do	1907	3,690,000	134,500	4
Do	1908	2,450,000	253,500	10
Coast Fork	1906	1,130,000	34,550	3
Do	1907	1,550,000	27,970	2
Do	1908	946,000	43,390	4
McKenzie	1906	3,350,000	437,000	13
Do	1907	3,910,000	424,000	10
Do	1908	3,020,000	434,000	14
North Fork Santiam	1906	2,830,000	191,600	7
South Fork Santiam	1906	2,520,000	86,300	3
Molalla	1906	656,000	26,230	4
Do	1907	721,000	18,850	3
Do	1908	592,000	22,260	4
Clackamas	1906	2,690,000	192,300	7
Do	1907	2,960,000	196,500	7
Do	1908	2,210,000	203,500	9
Luckiamute	1906	784,000	22,060	3
Do	1907	740,000	12,180	2
Do	1908	558,000	16,360	3

TOPOGRAPHY.

The mountainous portion of the Willamette drainage area comprises 5,000,000 acres or more. In the Cascades there are a number of high mountain peaks, among the most noted of which are Mount Hood, Mount Jefferson, and the Three Sisters. The elevation of the summit of the Cascades varies from 7,000 to 9,000 feet. The mountain slopes are very heavily timbered, affording excellent protection to the water supply coming from that side of the valley. The mountainous area merges into the valley area proper through a zone of low, rolling foothill country that is more or less wooded. The floor of the valley is a series of smooth, level areas known as "prairies" or "plains," whose slope is extremely uniform and ranges from 4 to 15 feet per mile. The north end of the valley is more or less broken and cut into lesser valleys by a series of low, rolling hills and by the foothills spreading over a wider area. In the south end of the valley—from Eugene as far north as Salem—the floor of the valley, although somewhat cut up by the various streams, is extremely even in slope, and large bodies of level prairie land are to be found. Along the streams are bottom lands, usually more or less wooded and subject to overflow in the winter time.

SOILS.

The soils of the valley are largely of basaltic origin. They are quite variable in character, but in general may be classified as follows:

Foothill soils.—These are confined to the higher rolling foothill sections. As a rule they have better natural drainage and are more friable than the soils of the prairies. In sections of the valley the hill lands are a sandy loam merging into a gravelly loam, not always of great depth, but usually deep enough for successful cultivation. In the foothills there is also a considerable area of what is locally called "shot land," because many of the soil particles have the form of small pellets resembling shot. In general the rolling hill land may be considered the best for fruit culture, because of its better condition, drainage, and freedom from frost.

Valley or prairie soils.—The soils of the floor of the valley are alluvial in character and vary greatly in texture from coarse gravelly loams, such as are found in parts of Marion and Lane counties, to the fine clay soils of Linn and Benton counties. The greater part of these soils, especially in the south end of the valley, may be classed as clay loams. These, as a rule, have a clay subsoil, but in many sections the subsoil is gravel. In the sections where the gravelly subsoil does not exist and where the surface drainage is poor, the heavy winter rainfall saturates the soil and hinders early cultivation in the spring. It is in such sections as these that the so-called "white lands," which are so unproductive, appear. They occur in isolated seams and patches throughout the darker colored loams, and are always found in low places and depressions where the drainage is poor and where during the winter season and far into the spring the land is under water. Except, perhaps, in the amount of humus contained, they have nearly the same chemical nature as the other clay loams that surround them, but they are compact and run together; that is, more or less puddled.

The soils of the valley which are likely to be most productive under irrigation are the gravelly and sandy soils and the friable clay loams of the foothills and prairies, all of which, as a rule, have good natural underdrainage. These lands no longer yield good crops of wheat, and for the most part now lie comparatively idle and unproductive. The greater part of this land lies in the south end of the valley in Lane, Linn, Benton, and Marion counties.

Bottom soils.—Soils of this type are found along the river and creek bottoms that are more or less subject to overflow, and are therefore quite limited in extent. They are the richest soils in the valley, being composed of alluvial deposits of basaltic origin mixed with sand and a high percentage of vegetable matter. They are easily cultivated

and are considered the most productive soils of the valley. What are commonly called "beaver dam lands" belong to this type. Except where these soils have an extremely porous subsoil or do not receive natural subirrigation from the higher lands, it is improbable that irrigation will be resorted to, except for some special use, such as market gardening.

Of the three types, the valley or prairie soils, by reason of their greater extent and because of their location and inability to withstand drought, will yield the largest return under irrigation.

CLIMATE.

Although in the same latitude as Montreal, the Willamette Valley, because of its proximity to that part of the Pacific coast which is washed by the warm Japan current, has an extremely mild climate. No extremes of either heat or cold are experienced. Summer temperatures rarely exceed 100° F., and then only for a very few days during the season, from 85° to 90° being the usual maximum temperature for summer. The nights are always cool. In winter the temperature is sometimes as low as 10°, but never for any considerable period. Periods of mild temperatures are frequent, and throughout most winters grass remains green in the meadows and pastures. The crop season proper extends from April 1 to about October 15, a period of nearly seven months. Cultivation can be begun as early as February 15 some seasons, but usually the farming season opens in March. Annuals, such as grain, planted at this time, usually mature successfully before the summer dry period, unless a drought occurs in May or early in June. Other crops whose growth extends into the dry summer months, unless favorably located on land that is naturally retentive of moisture, suffer in the dry months of July, August, and September.

The rainfall in the Willamette Valley is considerably greater than in the other valleys of western Oregon, but the increase is confined to the winter months when the rainfall is very heavy. During the summer months the rainfall is not greatly different from that in the Umpqua and Rogue River valleys. In the following table the normal rainfall as determined by the United States Weather Bureau at eight different points in the Willamette Valley is given. The several stations are all located in the bottom of the valley and the records given represent the precipitation in the section devoted to agriculture.

Normal rainfall at points in the Willamette Valley.[a]

Station.	Length of record (years).	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
		Ins.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*In.*	*In.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
Eugene	16	5.44	4.87	4.99	2.93	2.67	1.36	0.48	0.76	1.90	2.87	5.45	6.25	39.98
Albany	29	7.00	5.64	4.52	3.16	2.49	1.54	.50	.51	1.87	3.12	5.62	7.91	43.88
Corvallis	18	6.33	5.81	4.98	3.00	2.21	1.26	.26	.41	1.51	2.90	7.57	7.11	43.35
Monroe	12	6.95	7.53	5.94	2.69	2.06	1.19	.29	.64	1.65	3.14	9.08	8.15	49.31
Salem	17	5.42	4.40	4.51	3.08	2.61	1.29	.39	.46	1.60	3.08	6.56	5.91	39.31
Mount Angel	22	6.58	5.08	5.18	3.80	2.92	2.04	.64	.49	2.09	3.66	7.18	6.97	46.63
McMinnville	20	7.19	5.40	4.94	3.25	2.03	1.65	.40	.56	2.06	3.33	8.39	7.93	47.13
Portland	60	6.32	4.96	4.74	2.94	2.38	1.77	.75	.58	1.69	3.11	6.00	7.21	42.45
Average	...	6.40	5.46	4.98	3.11	2.42	1.51	.46	.55	1.80	3.15	6.98	7.18	44.00

[a] Figures furnished by United States Weather Bureau.

Although the records indicate that the south end of the valley receives slightly less rainfall than the north end, the variation is so small and so irregular as to cause practically no difference in agricultural conditions. With different years the rainfall varies quite widely—from 25 inches at Salem, in 1903, to 66 inches at Monroe, in 1902. The greatest variation, however, occurs with the different seasons of the year, over three-fourths of the yearly rainfall occurring during the winter season, from November to March, while during the summer period, from June to September, inclusive, very little rainfall occurs, the average during this period being less than 10 per cent of the yearly rainfall.

PHYSICAL CHARACTERISTICS OF THE UMPQUA VALLEY.

LOCATION AND SIZE.

The Umpqua Valley lies just south of the Willamette Valley and extends from the Calapooia Mountains on the north to the Canyon Mountains, which separate it from the Rogue River Valley on the south. The eastern boundary of the drainage system is the summit of the Cascade Range; the western boundary, the Pacific Ocean. The drainage basin extends north and south 70 miles and east and west 100 miles. It contains within its watershed approximately 3,000,000 acres of land.

STREAMS AND STREAM FLOW.

The Umpqua River, which drains the Umpqua basin, has its origin in the high Cascades, from which its two main tributaries, the North and South forks, flow. These two tributaries flow westward from their sources and join near the town of Roseburg. From that point the main stream flows in a northwesterly direction and empties directly into the ocean. There are numerous minor tributaries entering the main stream from both the north and the south. The prin-

cipal flow, however, comes from the North Fork and the South Fork. The discharge of the main stream and these two forks during 1906, 1907, and 1908 is given in the following table:

Discharge of Umpqua River and its tributaries, 1906–1908.[a]

Name of stream and place and time of measurement.	Drainage area.	Discharge.				Run-off.	
		Maximum.	Minimum.	Mean.	Total.	Per square mile.	Depth.
	Square miles.	*Cu. ft. per second.*	*Cu. ft. per second.*	*Cu. ft. per second.*	*Acre-feet.*	*Cu. ft. per second.*	*Inches.*
Umpqua River, Elkton: 1906		61,400	1,290	7,700	5,540,000		
North Fork Umpqua, Oakcreek:							
1906	1,000	26,800	952	3,930	2,830,000	3.93	53.12
1907		58,600	1,060	5,090	3,640,000	5.09	68.32
South Fork Umpqua, Brockway:							
1906	1,800	46,400	171	2,380	1,700,000	1.50	17.77
1907		68,800	182	3,790	2,700,000	2.11	28.29
1908		13,000	160	1,940	1,400,000	1.08	14.62

[a] U. S. Geol. Survey Water-Supply and Irrig. Papers Nos. 214 and 252.

Like the Willamette Valley streams, the streams of the Umpqua Valley have their heaviest discharge in the winter and spring months and their minimum discharge occurs during the dry period, when the demand for irrigation will be greatest. A comparison of the total annual flow of these streams with their flow during the summer season is given in the following table:

Yearly discharge and summer discharge of streams in Umpqua Valley, 1906–1908.

Name of stream and place of measurement.	Year.	Yearly discharge.	Discharge during July, August, and September.	
		Acre-feet.	*Acre-feet.*	*Per cent.*
Umpqua, Elkton	1906	5,540,000	296,000	5
North Fork Umpqua, Oakcreek	1906	2,830,000	232,000	8
Do	1907	3,640,000	241,800	7
South Fork Umpqua, Brockway	1906	1,700,000	53,900	3
Do	1907	2,700,000	44,700	2
Do	1908	1,400,000	46,880	3

TOPOGRAPHY.

The Umpqua Valley differs from the Willamette Valley in that it is not a true valley, but rather a succession of small valleys scattered at intervals along the main streams and separated from one another by ranges of hills. The arable area of these small valleys varies in size from a few hundred acres to 15,000 acres and more. Their elevation varies from tide water up to 1,000 feet above sea level. The larger and more important valleys lie near the junction of the North and South forks, in the vicinity of Roseburg. Here is found Garden Valley, which surrounds Roseburg; Coles Valley, lying 8 or 10 miles

lower down on the main stream; Sutherlin Valley, in the vicinity of Oakland; with Lookingglass, Happy, Myrtle Creek, and other minor valleys located in the same section. The elevation of these main agricultural areas varies from 400 to 600 feet above sea level. The mountainous areas to the eastward and also in the coast region are heavily timbered with fir, spruce, pine, and cedar, while the hills and bench lands in the agricultural section are covered with maple, oak, and scrub brush. The bottom land in the larger valleys is level and for the most part has been in cultivation for many years.

SOILS.

The valley soils are sedimentary deposits brought down from the hills, and for the most part are of a sandy nature and yield readily to cultivation. The foothill soils are lighter in texture, somewhat gravelly, and are reddish brown in color, due to the iron oxid they contain. The bottom soils along the streams are rich in vegetable matter, easy to cultivate, and very fertile.

CLIMATE.

In general the climatic conditions are much the same as in the Willamette Valley. The rainfall is somewhat less in the agricultural section, but its distribution is characterized by the same unevenness. The thermometer will register more than 100° F. in the summer occasionally, and in the winter will drop to 12° or 15°, but these may be considered as extreme temperatures, the climate being very moderate during all seasons of the year.

The annual rainfall of the valley section, taking Roseburg as the center, is approximately 35 inches. Eighty-six per cent of this rainfall occurs during the period from October 1 to April 30, leaving but 14 per cent, or 4.91 inches, for the five-month crop-growing season of May, June, July, August, and September, while the average rainfall during the months of June, July, and August is only 1.81 inches. For reference in the discussion to follow, the normal monthly and normal annual rainfall at Roseburg for 32 years, as given in the records of the United States Weather Bureau, are as follows: January, 5.64; February, 4.80; March, 3.83; April, 2.36; May, 2; June, 1.12; July, 0.35; August, 0.34; September, 1.10; October, 2.66; November, 4.33; December, 6.14; annual, 34.67 inches.

PHYSICAL CHARACTERISTICS OF THE ROGUE RIVER VALLEY.

LOCATION AND SIZE.

Rogue River Valley consists of two main valleys, the upper one surrounding the town of Medford and including most of Jackson County; the lower one surrounding the town of Grants Pass and

including most of Josephine County. It joins the Umpqua Valley on the north and extends southward to the summit of the Siskiyou Mountains, which follow in a general way the boundary line between Oregon and California. The eastern boundary of the drainage basin is the Cascade Range, the western the Pacific Ocean. The watershed of Rogue River contains approximately 3,000,000 acres of land, nine-tenths of which is rough mountainous territory, unfit for cultivation.

STREAMS AND STREAM FLOW.

Rogue River rises in the western slopes of the Cascade Range, between Crater Lake and Mount McLoughlin. Flowing thence westward, it passes in turn through the upper and lower valleys and then following a rugged, precipitous channel for a distance of 85 miles, it empties directly into the Pacific Ocean at a point about 35 miles north of the Oregon-California boundary line. Many tributaries join the main stream from both the north and south sides of the drainage area throughout its course. The more important of these, named in order as they enter the river on its way to the ocean, are: Big Butte Creek, Little Butte Creek, Bear Creek, Evans Creek, Applegate River, and Illinois River. All of these enter the main stream from the south, the greater part of the drainage area being on that side. With the exception of the Illinois River, which enters the main stream near its mouth and drains a rough, broken country, all of these tributaries have important bearing on the irrigation development of the two main valleys.

Only in recent years has any extended observation of the flow of Rogue River and its tributaries been made. The discharge of the main river is measured at Tolo, where it leaves the upper valley. Such data as is available, however, appears in the following table:

Discharge of Rogue River and its tributaries, 1907 and 1908.[a]

Name of stream and place and time of measurement.	Drainage area.	Discharge.				Run-off.	
		Maximum.	Minimum.	Mean.	Total.	Per square mile.	Depth.
	Square miles.	*Cu. ft. per second.*	*Cu. ft. per second.*	*Cu. ft. per second.*	*Acre-feet.*	*Cu. ft. per second.*	*Inches.*
Rogue River, Tolo:							
1907	2,020	48,300	1,190	4,450	3,180,000	2.20	29.54
1908		12,900	1,400	2,970	2,160,000	1.47	20.01
Little Butte Creek, Eagle Point, 1908	309	1,730	33	231	168,000	.75	10.17
Bear Creek, Talent, 1908	226	500	2	72.1	52,300	.32	4.33
Applegate River, Murphy, 1908	620	2,690	25	591	428,000	.95	12.93

[a] U. S. Geol. Survey Water Supply and Irrig. Papers Nos. 214 and 252.

Yearly discharge and summer discharge of streams in Rogue River Valley, 1907 and 1908.

Name of stream and place of measurement.	Year.	Yearly discharge.	Discharge during July, August, and September.	
		Acre-feet.	*Acre-feet.*	*Per cent.*
Rogue River, Tolo	1907	3,180,000	336,700	10
Do	1908	2,160,000	318,700	10
Little Butte Creek, Eagle Point	1908	168,000	8,180	5
Bear Creek, Talent	1908	52,300	2,121	4
Applegate River, Murphy	1908	428,000	22,680	5

TOPOGRAPHY.

Though the drainage area of Rogue River contains approximately 3,000,000 acres of land, but a small fraction of this can be classed as agricultural or tillable land. The entire area is essentially a broken, mountainous region similar to the Umpqua Basin, with the agricultural land lying in small valleys more or less isolated from one another by intervening ranges of mountains and hills. Outside of the two main valleys the level lands are confined to small areas found along the main streams and creeks. In the upper valley, extending from Rogue River south as far as Ashland, there are between 100,000 and 150,000 acres in one body divided about equally between valley and rolling foothill land. The lower valleys contain not to exceed 100,000 acres, and only about one-fourth of this is valley land proper, the remainder being hill land, more or less rolling and rough. The mountainous areas are heavily timbered with fir, pine, and other commercial varieties of timber, while the lower elevations surrounding the valleys, are covered with a growth of scrub pine, oak, laurel, and manzanita.

SOILS.

In no other part of the State is found such a wide variety of soils as occurs in the Rogue River Valley. The soils in the lower valley fall naturally in three classes, viz: (1) The alluvial soils of the river and creek bottoms; (2) the red foothill lands found in the Applegate, Fruitdale, and Evans Creek districts; and (3) the granite soils which cover the greater part of the foothill section on the north side of the valley. These three types of soil are not confined entirely to the localities mentioned, but are found more or less intermingled over the entire cultivable area, giving an extremely varied soil condition. Soils of the first two classes are more productive than the granite soils, because they contain a much higher percentage of organic matter and, being finer textured, are more retentive of moisture. The granite soils when put under irrigation and planted to leguminous crops, can be brought to a very productive condition and are found to be well adapted to the production of early fruits and vegetables.

The soils in the upper valley are, if anything, more variable than in the lower valley. No less than five types of soil occur in this region, all intermingled to such an extent that it would be difficult to select a 40-acre tract in this valley on which could not be found representatives of at least two of these types of soil. In certain localities, however, each of these different types predominates. In the south end of the valley near Ashland, the soil is largely a decomposed granite similar to that found in the lower valley. Along the bottoms of Bear Creek, running through the center of the valley, the soil is a rich alluvial deposit. On the east side of Bear Creek are found the "sticky" soils, which are heavy clay loams rich in organic matter. On the west side of Bear Creek black gravelly loams are found. In the north end of the valley on the "desert" are found the light gravelly soils, which have been brought down from the mountains by glacial action. A considerable part of this area is underlaid with a thin sheet of coarse cement gravel, underneath which is found both porous gravel and loam to a great depth. Around the foothills on both sides of the valley are found the typical red and black foothill soils, which are deep, well drained, and warm. All of these types are very productive, especially when irrigated. Crops are being raised on most of these soils without irrigation, but the production in most cases is not what it should be nor what it will be when adequate facilities for irrigating the land are provided.

CLIMATE.

Temperature conditions in Rogue River Valley are not greatly different from those in the Willamette and Umpqua valleys. The winters, with 12° to 15° F. as rare minimum temperatures, are extremely mild. In summer the temperature rises to 104° and 106° F. occasionally, but this heat is not oppressive, and such temperatures usually last only a few days at a time, being then tempered by breezes from the ocean. The last killing frosts in the spring occur usually in April, while the first killing frost in the fall occurs usually about November 1.

The annual precipitation in the agricultural section, taking Ashland, Jacksonville, and Grants Pass as centers of record, varies from 20 to 25 inches in the upper valley to 32 inches in the lower valley. The distribution of this rainfall is extremely uneven, the greater part occurring during the winter and spring seasons. The dry period comes on usually about June 1 and lasts into October. The average precipitation during the four-month period is but 2.5 inches. The normal rainfall at the three United States Weather Bureau stations in the valley is given in the table on page 19.

Normal rainfall at points in the Rogue River Valley.[a]

Station.	Length of record (years).	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
		Ins.	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*In.*	*In.*	*In.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
Ashland	30	2.90	2.37	2.13	1.45	1.65	1.05	0.46	0.38	0.75	1.43	2.31	3.30	20.18
Jacksonville	21	4.62	4.14	2.79	1.28	1.79	1.02	.19	.35	.91	1.77	3.81	4.67	27.34
Grants Pass	20	5.60	4.97	3.89	1.66	1.84	.94	.10	.33	.89	2.07	4.35	5.56	32.20
Average	....	4.37	3.83	2.94	1.46	1.76	1.00	.25	.35	.85	1.76	3.49	4.51	26.57

[a] Figures furnished by United States Weather Bureau.

THE NEED OF IRRIGATION.

Moisture, the sun's heat and light, and soil fertility are the three essentials to successful plant growth. With a deficiency in any one of these factors plants can not maintain a thrifty growth and development. All of the soils in the region under discussion are fertile except as they may have become impoverished by the destructive methods of cultivation employed in the past, but such deficiency as exists in this essential can be easily remedied by constructive methods of cultivation and fertilization. The two other essentials have a most important bearing on the question in hand and require a full discussion in order to determine on the theoretical side whether or not irrigation is needed to improve conditions in the region observed

The need of irrigation in any region, arid or humid, is determined, not by the total amount of rainfall occurring during the year, but by its distribution throughout the year; in other words, by the amount of rainfall occurring in the crop-growing season, May to October, during which period the warmth and light of the sun's rays are most effective. To illustrate graphically how unevenly the rainfall is distributed throughout the year in western Oregon the accompanying diagram (fig. 1) has been prepared. This diagram is based upon all the available records that have been kept by the United States Weather Bureau at the several stations given in the foregoing tables. The records at one of these stations have been kept for sixty years. The shortest period of observation, that at Monroe, in the Willamette Valley, is twelve years. The average upon which the diagram is based may therefore be taken as well established.

It will be seen from figure 1 that from October to March approximately 78 per cent of the yearly rainfall occurs. This is the dormant season during which there is no crop growth. During the period from April to September when there is warm weather and sunshine but 22 per cent of the rainfall of the year occurs. This 22 per cent, however, is not distributed evenly over the summer period, but comes mostly in April and May and in the latter part of September, so that

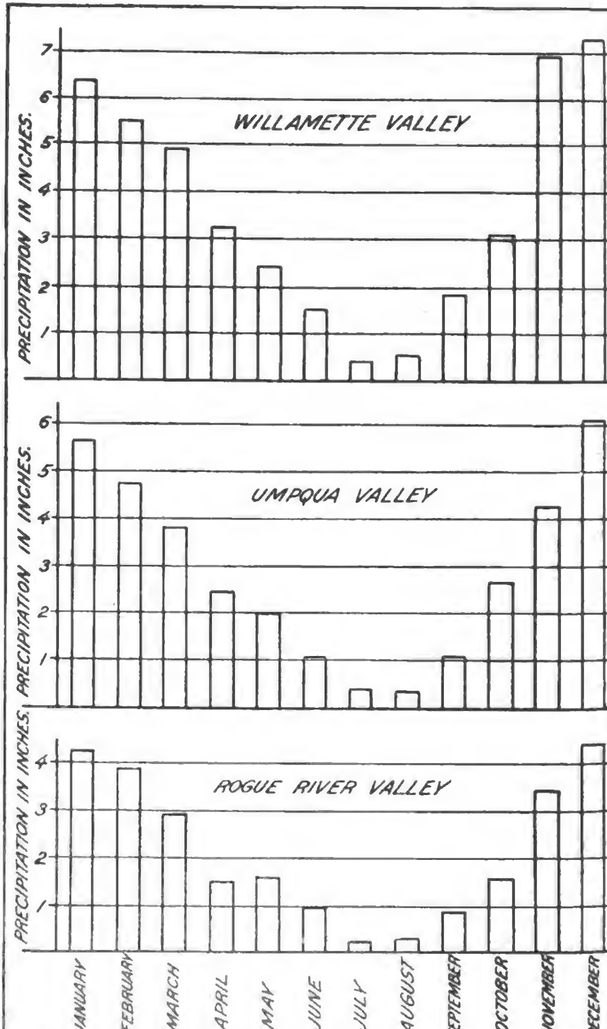

FIG. 1.—Diagram showing normal monthly rainfall in the three valleys of western Oregon.

[Bull. 226]

during the remainder of the crop-growing season there is actually an arid condition existing. The rainfall during June, July, and August—the three best growing months of the year—is but 2.52 inches in the Willamette Valley, 1.81 inches in the Umpqua Valley, and 1.60 inches in the Rogue River Valley, and the majority of the rains occurring in the summer period are little more than showers; although their aggregate makes a considerable showing, they are of little benefit to growing crops, because they do little more than moisten the surface of the soil and do not reach to the roots of most plants.

The season of 1907 in the Willamette Valley illustrates this point very clearly. The total amount of rainfall and its distribution were about normal. The summer rainfall came in three distinct shower periods, the first occurring in the latter part of June and the first part of July, the second occurring about the middle of August, and the third toward the end of August. The character of the rainfall occurring during these three periods at Portland, Albany, Corvallis, and Eugene is shown in the following table:

Shower period in Willamette Valley, summer of 1907.[a]

Date.	Portland.	Albany.	Corvallis.	Eugene.
First period:	*Inches.*	*Inches.*	*Inches.*	*Inches.*
June 28	0.28		0.18	0.03
June 29		0.16		
June 30				.02
July 1	.12			
July 2	1.00			
July 3	.06	.40	.24	.09
July 4		.02		
Total	1.46	.58	.42	.14
Second period:				
August 7	.15	.01	.28	.40
August 8	.07	.62	.21	.55
August 9		.02		.07
August 10	.02			
August 11		.04		
Total	.24	.79	.49	1.02
Third period:				
August 23				
August 24	.69	.12	.44	.45
August 25	.04	.25	.20	
August 26			.02	
Total	.73	.37	.66	.45
Total for season	2.44	1.74	1.57	2.61

[a] U. S. Dept. Agr., Office Expt. Stas. Circ. 78, p. 10.

The late spring rainfall ceased on June 15. Between that time and the beginning of the first shower period on June 28 there were a few isolated showers at different points in the valley, but no general rain. The heaviest shower at any point during this period was 0.09 inch at Portland on June 21. During the first period the heaviest shower occurred at Portland on July 2, when 1 inch of rain fell. The

only other rainfall of value was at Albany on July 3, when 0.40 inch fell. Between the first and second shower periods there was no rainfall anywhere in the valley except on July 14 and 25 at Eugene, when

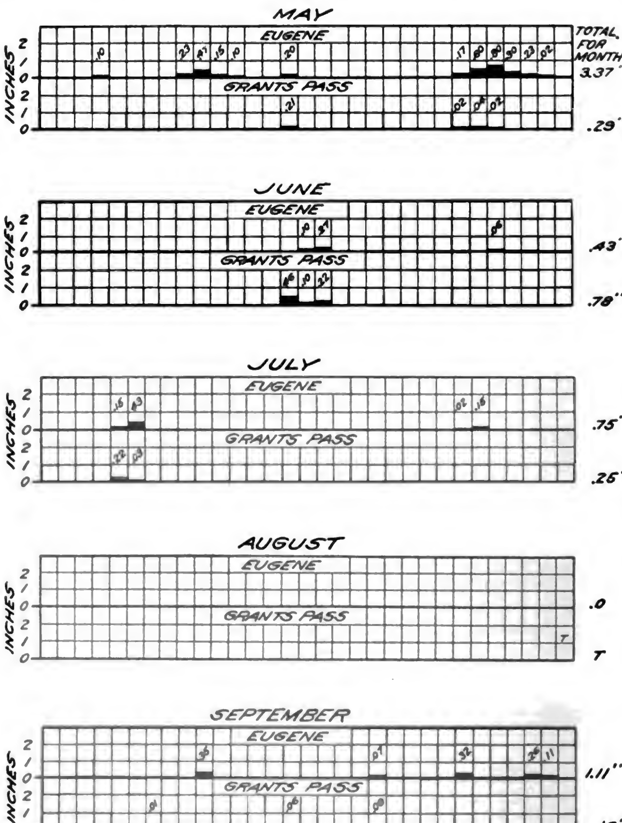

FIG. 2.—Diagram showing distribution and amount of rainfall during the summer months of 1909 at Eugene and Grants Pass.

0.04 inch and 0.05 inch occurred, respectively. These were so small, however, as to be negligible. For a period of thirty-three days, therefore, the valley was without appreciable rainfall. The total

rainfall during the shower period, averaging the four stations, was only 0.63 inch, spread over a portion of five days, about one-eighth inch per day, which was too small an amount to be of any value to crops. Between the second and third shower periods, twelve days, no rain fell, and during the third shower period the amount of precipitation—but little more than 0.55 inch—was so small as to be of little value on lands that had been subject to hot weather for fifty days.

To further illustrate this condition, figure 2 has been prepared. This diagram shows the distribution and amount of rainfall received each day during the months of May, June, July, August, and September, 1909, at Eugene, in the Willamette Valley, and at Grants Pass, in the Rogue River Valley.

Figure 2 shows that for the five-month period (May to September, inclusive) in 1909 the total rainfall at Eugene was 5.66 inches. Of this amount 3.37 inches fell in May, leaving for the remaining period of four months only 2.29 inches of rainfall. From July 26 to September 10, a period of six weeks, not a drop of rain fell. At Grants Pass the same condition in a more aggravated form existed. A rainfall of from 1 to 2 inches scattered over a period of ninety days in light showers of from 0.25 to 0.5 inch does no good to land that is as dry as practically all the valley lands are during July, August, and September. In exceptionally favored localities, on account of natural subirrigation, the soil with the aid of these light showers can be kept in good moisture condition, but these localities, while they form the greater part of the producing area at the present time, are in the aggregate very small indeed when compared with the larger area that is vitally affected by drought.

It is seen, therefore, that although 25 to 45 inches of rain fall annually in this region, it is so unevenly distributed that during the best months of the crop-growing season—June, July, August, and September—practically an arid condition exists, during which the precipitation is almost the same in amount as in the truly arid sections of Idaho, Washington, or Colorado, where irrigation is generally practiced. This is a fact not generally known, and by some would no doubt be considered a pretty broad statement. To substantiate it, the accompanying diagram (fig. 3), based upon records of the United States Weather Bureau, is introduced. This diagram compares on a common scale the rainfall conditions at Eugene and Grants Pass with the rainfall conditions at Sunnyside, Wash., Twin Falls, Idaho, and Denver, Colo., all well-known points in the arid region. The columns in outline show the total annual rainfall. The columns in solid black show the rainfall occurring during June, July, and August, while the dotted columns show the added depth of water which crops receive by irrigation during this same three-months

period in these three arid sections. This diagram brings out the fact clearly that conditions in the valleys of western Oregon during June, July, and August are as arid as those of the truly arid region during the same period.

To show still further how such a deficiency in moisture as occurs in the valleys of western Oregon each year is met under arid conditions, further reference will be made to one particular irrigated section of the Yakima Valley in eastern Washington. Climatic, soil,

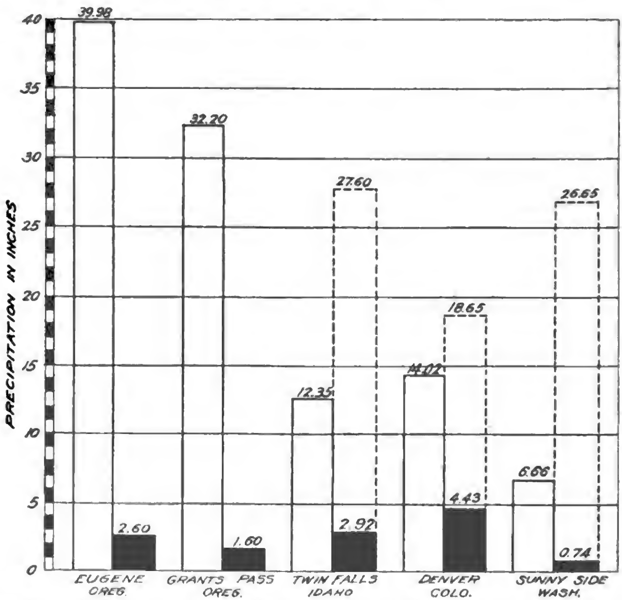

FIG. 3.—Diagram comparing normal annual and normal summer rainfall conditions in western Oregon with conditions during summer period in irrigated sections of Washington, Idaho, and Colorado.

and crop conditions are of course not exactly similar in the two sections, but are sufficiently so for the purpose in hand.

For a number of years the Office of Experiment Stations has kept records of the use of water under the Sunnyside Canal system in the Yakima Valley. In 1905 an accurate record was kept of the water applied under seven laterals of the Sunnyside Canal which supplied water to 4,355 acres of land. The irrigation season in that section in 1905 extended over a period of five months, beginning in May, but

for the sake of comparison with western Oregon conditions on a three-month basis the amount of water applied during July, August, and September only is given in the following table:

Water applied to lands under Sunnyside Canal, Yakima Valley, Washington, 1905.

No. of lateral.	July.	August.	September.	Total water.	Acreage.	Depth applied to land.
	Acre-feet.	*Acre-feet.*	*Acre-feet.*	*Acre-feet.*	*Acres.*	*Inches.*
39. 1	380	358	275	1,013	496. 4	24. 48
34. 1	603	600	315	1,518	1,355. 0	13. 56
32. 3	940	956	573	2,469	1,150. 0	25. 68
29. 1	294	272	104	670	333. 0	24. 12
19. 6	273	200	178	651	275. 0	28. 32
20. 4	231	212	106	549	198. 0	33. 12
27. 1	535	301	381	1,217	547. 5	26. 64
Total				8,087	4,354. 9	22. 28

It will be noticed that the lateral supplying the least water delivered upon the land 14 inches in depth, while the lateral supplying the greatest amount delivered 33 inches in depth. For all the laterals the mean amount applied during this three-month period was 22 inches. During the three months the rainfall at Sunnyside amounted to 1.77 inches. In the Willamette Valley during the same three months in 1905 the rainfall averaged 1.58 inches. In the Yakima Valley, therefore, land in crop received during July, August, and September 24 inches of water, while land in crop in the Willamette Valley received only 1.58 inches. This wide variation in the amount of water received by the crops in the two valleys during the three-month summer period is worthy of careful note, and while the two valleys are not exactly comparable, and the amount of water applied under the Sunnyside Canal may have been more than was actually required, the comparison seems to fully warrant the conclusion that could the natural rainfall in the Willamette Valley be supplemented by irrigation, as is done in the Yakima Valley, a far greater and at the same time safer use could be made of the lands that are now doing only partial duty.

As showing what is already being accomplished with irrigation under climatic conditions similar to those existing in the Willamette Valley, brief reference will be made to the Po Valley in Northern Italy,[a] where, notwithstanding the existence of a humid climate, irrigation has been depended upon for centuries to bring about the fullest agricultural production. The upper part of the valley of the Po resembles in many respects the Willamette. On three sides it is surrounded by high mountains—the Alps on the north and east, and the Apennines on the south—from which a network of streams make their way to the Po, the trunk stream of the valley. The valley

[a] U. S. Dept. Agr., Office Expt. Stas. Buls. 144 and 190.

itself consists of a foothill section and a broad level plain, situated in practically the same latitude as the Willamette. The climate of the two valleys is very similar. In the Provinces of Piedmont and Lombardy the temperature varies from zero to 100° F. The crops raised are those of the temperate zone—cereals, hay, vegetables, and fruit. The rainfall varies from 30 to 40 inches, and irrigation is practiced extensively.

The annual rainfall at Milan, the heart of the great irrigated district of Lombardy, averages 40 inches, nearly as much as in the Willamette Valley, while at Turin, the capital of Piedmont, it is 31 inches. The distribution of this rainfall is far more even and more favorable to plant growth than that in the Willamette Valley, as indicated in the accompanying summary.

Distribution of rainfall by seasons at Milan and Turin, Italy, and in the Willamette Valley, Oregon.

Locality.	Annual rainfall.	Winter.	Spring.	Summer.	Autumn.
	Inches.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Milan	40	21.3	23.9	23.9	30.9
Turin	31	14.7	26.3	31.6	27.4
Willamette Valley	44	38.3	16.0	6.4	39.3

The above table shows that for the spring and summer months the rainfall in the Willamette Valley is only about one-half that at Milan. During the driest month of the year more rainfall occurs on the average at Milan than during the whole three months' summer period in the Willamette Valley. In the Province of Piedmont alone, which is a little smaller than the Willamette Valley, over 700,000 acres are under irrigation (1903), twice as much as in the whole State of Oregon, and the canals and laterals built by the Italian Government, to say nothing of those built by private capital, aggregate in this one Province a length of 926 miles. Irrigated land under the Villoresi Canal is valued at $160 to $200 per acre, while unirrigated land sells for $100 per acre. On this point Elwood Mead says:

> The conditions under which farmers work in this part of Italy are wholly different from those which prevail in the arid regions of America. In the midst of the Corbetta district farms are being cultivated without irrigation which grow the same crops as surrounding farms that are artificially watered. Farming by rainfall alone here is not unlike farming in Kentucky, Tennessee, southern Missouri, and northern Arkansas. The rainfall in Italy is, if anything, a little greater and is equally well distributed.
>
> In the fields devoted to wheat only one crop a year is grown where irrigation is not practiced, but where the land is irrigated a good crop of corn, beans, or cabbage can be planted and brought to maturity after the wheat is harvested. Without irrigation, clover and alfalfa, if sown with wheat, make a small growth, but with irrigation a good crop can be cut the same year after the wheat is harvested, and the stand in succeeding years is better because of the vigorous growth while the plants were young, due to irrigation.

It is not alone in theory that the valleys of western Oregon need irrigation; it is a fact. It is only necessary to observe the appearance of the valley lands in the latter part of July, in August, and in September. They are parched and brown at the very time they should be producing their maximum crops. Where clover is being raised the second crop stands a few inches high, scorched and dry. Other crops not located on bottom land are in the same condition. The vigorous growth that should be seen is lacking. All production is at a standstill during this the best season of the year, waiting for the "fall rains" to begin. As the direct effect of this condition the dairy herd is put upon winter rations in the summer time. Cows can be provided with green food the winter through and during the spring and fall seasons, but in the summer time they are put on dry hay and mill feed. Hay sells for $14 to $18 per ton and mill feed for $25 to $28 per ton, which at once creates abnormal conditions. Each year hundreds of thousands of dollars' worth of ham, bacon, lard, butter, eggs, and canned goods are shipped into these valleys from outside the State for consumption here; and all this in an agricultural section that should be exporting all such products instead of importing them. Verily there is need for irrigation in these valleys of western Oregon.

EXPERIMENTAL INVESTIGATIONS.

To determine just what benefit would result from irrigation, a series of experiments under field conditions were undertaken. This work was confined entirely to the Willamette Valley. It was begun in the spring of 1907 and has been continued through the seasons of 1908 and 1909. On account of the varying soil conditions, it seemed desirable to have the experimental tracts so located as to include the representative soil types. The main part of the experimental work and observations has been confined to the sections near Corvallis, Albany, and Hillsboro, where opportunity was afforded for a study of nearly every phase of the general problem.

All experimental work has been carried on under cooperative arrangements with those whose substantial interest has made it possible to do much more with the funds available than would have been the case if the Office of Experiment Stations had been forced to bear the entire expense of equipping and conducting the experimental tracts. The cooperators with the Office in this investigation and the location of the experimental tracts, are as follows:

(1) The Oregon Agricultural Experiment Station. The tract used was part of the station farm located 1 mile west of Corvallis, in Benton County.

(2) George R. Bagley. This farm lies 6 miles northwest from Hillsboro in Washington County.

(3) Cockerline and Howard. This farm lies 2 miles south of Albany in Linn County.

In addition to the experimental work at these three places, observations as to the effect of irrigation have been made at different times during the period of investigation on the following places where irrigation has been adopted recently.

Oswald West's hop yard, 3 miles south of Corvallis, Benton County.

Johnson and Bryson's ranch, 3 miles north of Monroe, Benton County.

Robert Gallatly's ranch, 3 miles south of Philomath, Benton County.

H. Hunteman's farm, 2 miles west of Hillsboro, Washington County.

Z. Wood's farm, 1 mile west of Hillsboro, Washington County.

F. B. Chase's market garden, 1 mile north of Springfield, Lane County.

IRRIGATION AND CULTURAL METHODS EMPLOYED.

Although the experimental tracts were located in different sections of the Willamette Valley, and each presented entirely different conditions, the crops raised, the cultural treatment, and the irrigation methods employed were kept as nearly uniform as possible throughout all the experiments, so that a comparison of results would be possible, and also for the purpose of more easily locating any errors or mistakes that might have occurred. As the methods employed were exactly the same on all the experimental tracts, they will be discussed under the following general head:

PREPARATION OF LAND FOR IRRIGATION.

Subsoiling.—On all the stations, with the exception of the state experiment station, the land used had at one time or another been cropped extensively to wheat, with the result that a hard, impervious plow sole or artificial hardpan had been formed at about 6 inches beneath the surface. It has been noticed generally by farmers, especially those who have come to the Willamette Valley from other sections, that the average soils here are more or less unresponsive to cultivation and that they require much more work to make them produce than soils of many other localities. This condition is due in a large measure to the existence of this plow sole and to the condition of the surface soil for which it is responsible. This plow sole isolates the few inches of surface soil from the deeper and unexhausted subsoil and not only cramps the root development of plant but serves as an effective barrier to the passage of moisture in either direction. To break up this plow sole the land put into irrigated

crops was thoroughly subsoiled. This was accomplished by plowing 8 to 10 inches deep with an ordinary walking plow and following in the furrow with the subsoiler put down another 8 inches. This stirred the soil thoroughly to a depth of 16 to 18 inches and completely destroyed the artificial hardpan. Very little of the subsoil was brought to the surface by this operation and nothing but beneficial effects have been noticed on the tracts so treated. The subsoiling was done with three and four horses, at a cost about the same as for an ordinary deep plowing.

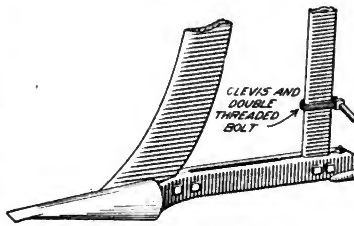

FIG. 4.—Subsoiler used on Bagley farm.

Two types of subsoil plows were used. The type shown in figure 4 seemed to give the best results on the lighter soils of the Hillsboro farm, while the type shown in figure 5 seemed to give the best results on the Albany farm, where the soil is of a heavier nature. The bolt and clevis attachment on the rear standard, shown in figure 5, was found necessary to more thoroughly break up the subsoil loosened and raised by the shoe. This was put on after the work had begun and was found to leave the subsoil in the furrow in much better condition than where it was not used.

Plowing.—The plowing was done with an ordinary 14-inch walking plow and three horses, to a depth varying from 6 to 10 inches. After plowing and subsoiling, the land was struck in both directions with an ordinary drag harrow, which left it ready for leveling.

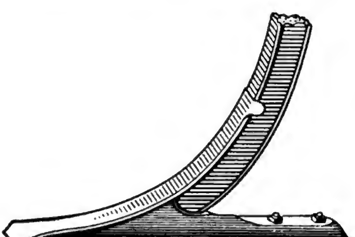
FIG. 5.—Subsoiler used on Cockerline and Howard farm.

Leveling.—Before any land is ready for irrigation, and especially the lands in the Willamette Valley, where to prevent baking of the surface a minimum amount of water should be applied, it should be trued up and brought to a uniform slope free from depressions and potholes in which water could collect and stand. In leveling the fields being experimented upon and in preparing them for irrigation, the leveler shown in figure 6 has proved very successful. This leveler has been used quite extensively in eastern Oregon and eastern Wash-

ington on the light ash soils of those sections, and from the experience gained in the Willamette Valley it seems to be well adapted to the heavier soils found there and, where properly handled, will give results that are very satisfactory.

Two sizes of leveler were used, one 12 feet long and requiring four horses; the other 16 feet long and requiring six horses.

Either size can be operated by one man, both rough work and the finishing being done with the same implement. Where the land is very uneven, the whole field is not plowed, to begin with. The tops alone of all high places are plowed and the earth moved into the low places until the whole surface is brought to a fairly uniform slope. With this rough work done, the field is then plowed and the surface finished by light leveling. All ditch lines should be located before the land is leveled, so that in the process of leveling the proper slope may be given the land with regard to the laterals that are to supply the water.

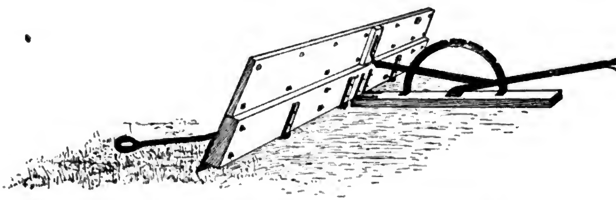

FIG. 6.—Leveler used in preparing land on experimental tracts.

The cost of preparing land for irrigation will of course vary with different conditions, but to convey some idea of what the cost should be on average lands in the Willamette Valley, the following cost data are given.

In preparing 5 acres of rather smooth land for alfalfa on the West farm the past season, the following expense was incurred:

Plowing, 3 days, at $4 per day	$12.00
Leveling, 2 days, at $4 per day	8.00
Harrowing, 2 days, at $3 per day	6.00
Furrowing land, 1 day, at $3 per day	3.00
Total cost ready for seeding	29.00
Cost per acre	5.80

The cost of leveling alone on 20 acres on the Bagley farm amounted to $25, giving an acreage cost of $1.25 per acre. These costs, it should be noted, are low, owing to the naturally level character of the land. They represent quite truly, however, the prairie class of land, of which there are thousands of acres in the valley.

IRRIGATION METHODS.

Securing a water supply.—In securing a water supply for irrigation two methods have been employed. On the Albany farm the supply is obtained by gravity flow from a large power canal which flows through the tract that is being used for experimental purposes. On all the other farms the water is secured by pumping from bodies of open water. On two of these places gasoline engines have been installed to supply the power to drive the centrifugal pumps, while on the other farm—that of Mr. Bagley near Hillsboro—the power for driving the centrifugal pump is derived from a turbine water wheel, which in the past has been used to supply power for an old grist mill that is on the property. By employing these different methods of securing water it has been possible to demonstrate the chief ways in which water for irrigation may be secured and to determine their relative effectiveness.

Distribution and application of water to fields.—With the fields leveled and the water supply provided, the next question naturally arising is how best to apply the water to the soil so as to produce the most beneficial results. Sandy soils have little tendency to bake under irrigation, but the direct application of water to the surface of clayey soils

Fig. 7.—Sketch showing subirrigated condition where furrows are used.

is attended by the formation of a hard crust on the surface, which, if it can not be broken by cultivation, seriously retards the growth of the plant. This crust forming and baking process is also attended in practically all of the clay loams of the Willamette Valley prairie lands by a "running together" of the soil particles where too great a degree of saturation is permitted. To avert these difficulties the furrow method of irrigation has been adopted almost exclusively. By this method water can be applied in irrigation without wetting the surface soil except immediately adjacent to the furrow, and thus all damage from baking or running together is obviated. In laying out a furrow system the field must be brought to a comparatively uniform slope, and after the crop is seeded small furrows 2 to 4 inches in depth are run in a direction that will give the proper slope, at intervals of 30 to 36 inches. The water is admitted to these small furrows from a head ditch or flume, and a small stream is permitted to flow into each until the soil between the furrows has become thoroughly subirrigated, producing the condition shown in figure 7. In making these furrows the implement shown in figure 8 has been used on the experiment farms. It makes three furrows at

once, 30 inches apart. The short rounded timbers which make the furrows are shod on their front end with a piece of sheet steel to prevent wear on the corners. The arm extending to the left carries a

FIG. 8.—Furrower, or marker.

marker, which traces a line in the soft earth, showing where the outside shoe must follow on the return trip across the field. This furrower is operated with two horses and is weighted by the driver standing on the platform. The cost was $13 for the marker complete as shown in the figure.

FIG. 9.—Head flume used in distributing water.

Methods of distribution.—Both the open head ditch and small wooden flume have been used in the distribution of water to furrows. Figure 9 shows the water being distributed from a head flume. This

flume is made of 1-inch lumber and is 12 inches wide and 12 inches deep. Water is discharged into the furrows through 1-inch holes bored in the side of the flume, the flow from each orifice being controlled by a lath button fastened to the side of the flume with one nail in such a manner that it will cover all or part of the orifice, as desired. The length of the furrows shown in the figure is 275 feet, which has been found to be about the right length for furrows on the prairie soils of the valley.

The method of distributing water from a head ditch is illustrated

FIG. 10.—Method of distributing water from head ditch by means of lath spouts.

in figure 10, which is a photograph taken on the Bagley farm, showing the irrigation of corn. The head ditch was made by turning a deep furrow either way and with a shovel cleaning out the rough channel thus formed. The grade of the ditch was about 1 foot per hundred. The water was checked in the ditch by means of a canvas dam made from an old binder apron, the canvas being nailed to a crosspiece of 1 inch by 4 inch timber, as shown in figure 11. The crosspiece was long enough to reach from bank to bank and the

canvas sheet 4 feet square was large enough to reach from one side of the ditch to the other and cover quite an area on the bottom of the ditch. By putting a few shovelfuls of earth on the edges of the canvas an effective dam was secured. The water, after being checked by the canvas dam, was admitted to the furrows through spouts placed in the ditch bank. Four of these spouts are shown on the ditch bank in figure 10. They were made of ordinary lath, as shown in figure 12, a 4-foot length making two spouts. With the head used, 300 gallons per minute, it was possible to supply from 15 to 18 streams at one setting. After the water had remained in the furrows from four to six hours, the dam was moved down the head ditch and a new set of furrows supplied. In the use of this method of distribution a very even irrigation could be applied, with no danger of flooding the surface soil if the land had been sufficiently leveled. The water gradually seeped from the furrows into the soil, saturating the subsoil and leaving the surface soil comparatively dry. In the course of a day or two the excess of water in the subsoil would gradually be drawn to the surface by capillarity and thus moisten the soil surrounding the root system of the plant.

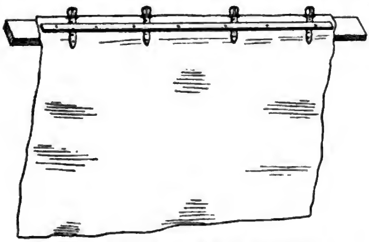

FIG. 11.—Canvas dam made of old binder apron.

Cultivation after irrigation.—To conserve the moisture that had been placed in the soil and to break up the crust that might form in the bottoms of the irrigated furrows, all crops in rows were cultivated with a 1-horse cultivator as soon after irrigation as possible. This not only loosened the surface soil in the furrows, but left it in fit condition for subsequent irrigation.

FIG. 12.—Method of making lath spouts.

CLIMATIC CONDITIONS DURING PERIOD OF INVESTIGATION.

Climatic conditions during 1907 and 1909 were practically normal. During 1908, conditions were abnormal in that a late cold spring was followed by an early killing frost in the fall, and as a result the usual season of crop growth was greatly shortened. Aside from the shortness of the season, average conditions in general prevailed in 1908.

CLIMATIC CONDITIONS IN 1907.

Weather conditions during the twelve months of 1907 may be briefly summarized as follows:

January.—Unusually cold; precipitation slightly above normal.

February.—Normal conditions prevailed.

March.—Slight deficiency in rainfall; otherwise normal conditions prevailed.

April.—Normal conditions prevailed.

May.—Warm and dry; precipitation below normal.

June.—Temperature normal. Rainfall slightly above normal; beneficial showers, 10 to 14, and 21 to 22.

July.—Temperature normal. Rainfall slightly below normal and occurring in scattered showers.

August.—Normal conditions prevailed.

September.—Normal conditions prevailed except for slightly higher temperatures.

October.—Mild temperatures and very dry.

November.—Normal conditions prevailed.

December.—Precipitation abnormally heavy.

The crop-growing season of 1907 represented normal conditions almost throughout the period. The dry period came on about three weeks earlier than usual, beginning early in May, but well-distributed showers in the middle and latter part of June relieved the droughty condition then existing. During July, August, and September scattering showers were received at intervals, but these were of local nature and in most cases were so slight as to do little good. Irrigation was commenced on the different tracts during the first ten days in July, and from that date to September 15 typical droughty conditions existed.

CLIMATIC CONDITIONS IN 1908.

Weather conditions during 1908 were, in brief, as follows:

Climatic conditions in Willamette Valley, 1908.

January.—Unusually dry and mild, remarkably even temperature, rainfall deficient.

February.—Mild and dry, precipitation in form of rain entirely.

March.—Normal temperatures, marked deficiency in precipitation.

April.—Sharp contrasts in temperature, heavy frosts end of month, two storm periods 3 to 6, and 15 to 24.

May.—Excessive cloudiness accompanied by low temperatures, rains frequent and heavy, conditions not conducive to good crop growth.

June.—Average conditions prevailed, precipitation somewhat below normal, principal shower period 15 to 23.

July.—Warm and very dry, precipitation only one-fourth normal, distributed in three light shower periods, 3, 12, and 13.

August.—Temperatures normal, rainfall above normal, no rain before the 12th, occurred in two periods 12 to 13, and 17 to 25.

September.—Low temperatures, exceptionally low rainfall, killing frosts 23 to 26.

October.—Normal conditions, heavy rainfall 10 to 20.

November.—Marked deficiency of precipitation.

December.—Unusually dry and cold.

The entire crop-growing season of 1908 was rather exceptional in character and was not conducive to the best growth of crops. Following an exceptionally open and mild winter, the spring season was of unusual severity, being rainy and cold until late in the season; spring cultivation and seeding was delayed nearly a month in some sections. Following the cold spring a hot, dry summer came on abruptly, with the result that on the experimental tracts it was necessary to "irrigate up" some of the crops. Owing to the heavy nature of the valley soils this procedure was not attended with success, and as such a practice would ordinarily be unnecessary, abnormal conditions were at once created. All the crops being experimented upon were, under the conditions described, three or four weeks behind in their growth. To complete the abnormality of the season, a killing frost occurred on September 23 and 24, and did great damage throughout the valley and on the experimental tracts, killing most of the crops from which it was hoped definite results would be secured. With but few crops matured when this freeze occurred, it will not be possible to give accurate results of yields under irrigation in 1908, except for those crops that were not seriously damaged. A full and complete description of the appearance of the crops will be given, however, so that in the absence of definite results some idea may be had of the effect of the irrigation during the dry summer season.

The amount of summer rainfall in 1908 was about normal. The dry period extended from June 12 to September 12 and later. During those three months the total rainfall was 2.5 inches. This, it is seen, is practically the normal. The distribution of this rainfall was very uneven. The greater part of June was dry, a small shower period occurring from the 15th to the 23d. July was excessively dry, only 0.04 inch of rainfall occurring during the entire month, and this came in light scattered showers, which did no good whatever. In August no rain fell until the 12th, when the six-week drought was broken by a two day shower period during which 1 inch of rain fell all over the valley. Toward the end of August there was another shower period, but the rain was so light and the soil so dry that little permanent good was done. From August 28 to October 10 droughty conditions prevailed throughout the valley. On October 10 heavy rains set in, closing the dry season for the year. Had other weather conditions been as nearly normal as the rainfall, the season of 1908 would have been an excellent one for experimental work. The late cold spring and the killing frosts in the early fall made the season so short however, that it was impossible to secure the proper growth of crops.

CLIMATIC CONDITIONS IN 1909.

Weather conditions during 1909 were as follows:

January.—Remarkably cold weather with heavy snows during first of month. Latter half of month mild with frequent rains; precipitation greater during month than for any other January for 20 years.

February.—Almost continuous rainfall; with two exceptions precipitation was the heaviest of any February for 20 years.

March.—Rainfall about one-half normal; temperatures slightly above normal.

April.—Extremely dry with low temperatures and frequent killing frosts.

May.—Unusually dry and cool; heavy shower period closed the month and improved crop conditions greatly.

June.—Warm and dry with showers in middle and toward end of month.

July.—Normal conditions prevailed.

August.—Normal conditions prevailed.

September.—Temperatures normal; rainfall somewhat below normal.

October.—Normal conditions prevailed.

November.—Excessive rainfall causing heavy floods in all streams.

December.—Unusually cold, with heavy snow fall general over the Northwest.

Aside from a very dry and rather cool spring during April and May the crop growing season of 1909 may be considered quite normal. The drought and cool weather of these two months did not seriously affect crop growth, for with a good general rain the last of May along with high temperatures early in June, all crops received a good start in their growth. Two rather general showers, one the middle of June and one about July 4, brought crops to their normal condition. The dry period set in immediately after the rains in the first week of July and irrigation was commenced shortly after that time. Favorable conditions continued until harvest on all the experimental tracts. The continued drought during July, August, and September told heavily on all crops not favorably located. With conditions so nearly normal therefore, both as to rainfall and temperature, the season of 1909 may be considered as very favorable for the experimental work.

The rainfall during the period of investigation, as shown by the United States Weather Bureau records at Portland, Corvallis, Albany, and Eugene, is given in the following table:

Precipitation at different points in Willamette Valley during period of investigation, 1907, 1908, and 1909.

Month.	Portland.			Corvallis.			Albany.			Eugene.			Average.		
	1907.	1908.	1909.	1907.	1908.	1909.	1907.	1908.	1909.	1907.	1908.	1909.	1907.	1908.	1909.
	Ins.	*Ins.*	*Ins*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
January	8.23	4.73	9.29	8.97	4.24	13.61	7.54	3.92	8.77	7.91	2.82	7.95	8.15	3.93	9.85
February	3.54	2.85	7.03	5.38	4.10	9.45	4.81	3.02	7.61	6.07	2.67	7.71	4.95	3.16	7.95
March	3.86	4.39	2.35	5.39	4.33	1.93	4.43	3.86	1.81	4.65	2.87	1.76	4.58	3.86	1.96
April	3.57	3.38	.89	2.98	1.99	.26	2.70	1.64	.56	4.03	.81	.43	3.32	1.96	.54
May	1.37	4.66	1.79	1.27	2.89	1.39	1.28	2.76	1.32	1.38	2.46	3.37	1.33	3.19	1.97
June	1.84	.67	.17	1.11	1.38	.30	1.30	.86	.22	1.40	1.76	.43	1.41	1.17	.28
July	1.19	.05	2.26	.24	0	1.10	.44	.08	1.34	.18	.02	.75	.51	.04	1.36
August	1.02	1.34	.05	1.15	1.00	.11	1.10	.82	.30	1.47	.76	0	1.19	.98	.12
September	1.73	.23	.95	1.17	.23	1.16	1.15	.40	.93	1.23	.37	1.11	1.32	.30	1.04
October	.93	5.17	2.01	1.32	4.34	4.51	1.21	3.68	4.02	1.33	5.04	3.54	1.20	4.56	3.52
November	6.51	3.10	12.49	7.92	4.01	11.53	6.78	4.07	11.86	4.69	3.67	8.51	6.48	3.71	11.10
December	9.10	3.80	4.47	13.33	4.78	....	11.70	3.43	4.96	11.93	3.96	3.60	11.52	3.99	3.26
Total	42.89	34.37	43.75	50.23	33.29	....	44.44	28.54	43.70	46.27	27.21	39.16	45.96	30.85	42.95

EXPERIMENTS IN COOPERATION WITH THE AGRICULTURAL EXPERIMENT STATION, CORVALLIS, OREG.

Under the terms of the cooperative agreement between the Office of Experiment Stations and the State Agricultural Experiment Station, the station provided a tract of 10 acres for experimental purposes and planted, cultivated, and harvested all crops, while the Office provided and installed the pumping plant, laid out the irrigation system, and attended to the irrigation work.

Water was secured from Oak Creek by means of a pumping plant, which was installed in 1907. The pumping equipment consisted of a 4-horsepower gas engine and a 3½-inch centrifugal pump. During the seasons of 1907 and 1908 the water was lifted to a height of 15 feet

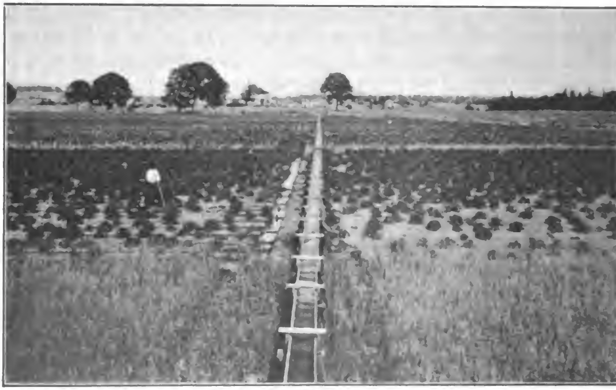

FIG. 13.—Corvallis irrigation plats.

and discharged into a flume 700 feet long that delivered it to the experimental plats, located during these two seasons on the north side of the Corvallis and Eastern Railroad track. In 1909 the experiment was moved to the south side of the track, where better soil conditions prevailed and where the pumping plant could be located on experiment station land. The pumping plant in its new location still takes its supply from Oak Creek, but the lift is increased to 19 feet. The arrangement of plats in the new location with regard to the distributing flume is shown in figure 13. The photograph is taken from the roof of the pump house. All crops were planted in duplicate plats, the irrigated plats lying to the left of the flume and the unirrigated to the right.

The discharge of water is measured over a 1-foot trapezoidal weir placed at the end of the main distributing flume. When the engine

and pump were up to full speed the discharge in the flume was measured over the weir, the water escaping down a waste ditch. When the flow had become constant it was turned out upon the plat to be irrigated. After the irrigation of each plat another observation of the flow over the weir was taken. In this way it was possible to use the weir as a measuring device without loss of head in the distributing flume.

The soil being experimented upon is a rather heavy gray clay loam typical of many thousands of acres in this section of the valley. The subsoil is heavier clay. The surface drainage is good, the land having a general slope toward Oak Creek on the west and south, while a small part slopes toward the north into a slight depression that also drains toward the creek. The land used in 1907 and 1908 had been in cultivation for a number of years, while the land used in 1909 had been in cultivation to oats but one year. Prior to that time it had been used for several years as pasture.

RESULTS IN 1907.

In 1907 the following crops were irrigated, with the results shown:

Corn.—A plat of one-half acre was planted to field corn on June 14. On June 29, when the corn was about 3 inches high, the land was irrigated for the first time. In a few days the irrigated corn showed the effect of the watering very plainly, and in three weeks it had a decided advantage in growth and vigor over the plat of unirrigated corn. On July 29 the second irrigation was given to a part of the plat which received the first irrigation. During the first week in October the crop was harvested and the following yields were secured:

Yield of irrigated and unirrigated corn at Corvallis, Oreg., 1907.

Treatment.	Green fodder per acre.	Increase.
	Pounds.	*Per cent.*
Unirrigated	5,647	....
Irrigated once	7,000	24
Irrigated twice	9,666	71

Potatoes.—The area planted to potatoes was the duplicate of that planted to corn. The potatoes were planted at the same time as the corn and received the same cultural treatment. The yields were as follows:

Yield of irrigated and unirrigated potatoes at Corvallis, Oreg., 1907.

Treatment.	Yield of marketable tubers per acre.	Increase.	Marketable tubers.
	Pounds.	*Per cent.*	*Per cent.*
Unirrigated	2,604	....	89.2
Irrigated once	6,760	160	88.0
Irrigated twice	7,500	180	93.2

RESULTS IN 1908.

In 1908 an effort was made to include, in addition to the above crops, alfalfa, vetch, and clover. Plats of clover and vetch were planted in the fall of 1907 and a plat of alfalfa was planted in the spring of 1908. Unfortunately, however, none of these crops produced a stand. From a plat of second-year clover, however, results were secured which illustrate the value of irrigation on clover which has once become established.

The results secured from the various crops raised in 1908 are as follows:

Corn.—A plat of 1.44 acres was planted to field corn on June 15, 1908. It was irrigated once on August 1 and 2. Water should have been applied several days earlier, but owing to a breaking of one of the parts of the engine the application of the water was delayed. The weather at the time was very warm, and the corn not irrigated showed the effects of the drought by curling of leaves and a general wilted condition. The effects of the water was noticeable at once in the increased vigor of the plants and their ability to stand the hot sun with no indication of wilting or curling. No yield of mature corn was secured, as the frost of September 23 prevented ripening and the crop had to be cut for fodder. The yields of green fodder cut from the plats are reported in the following table in terms of pounds per acre:

Yield of irrigated and unirrigated corn at Corvallis, Oreg., 1908.

Treatment.	Green fodder per acre.	Increase.
	Pounds.	*Per cent.*
Unirrigated	7,280	
Irrigated once	9,640	32.4

Potatoes.—One-twelfth of an acre of potatoes was planted on June 15. They were irrigated and cultivated in the same manner as the corn just described. The frost also caught these before the tubers were fully matured, so that no fair statement of comparative yields can be given. The yields were as follows:

Yield of irrigated and unirrigated potatoes at Corvallis, Oreg., 1908.

Treatment.	Yield of marketable tubers per acre.	Increase.	Marketable tubers.
	Pounds.	*Per cent.*	*Per cent.*
Unirrigated	3,626		66.6
Irrigated once	5,041	39	88.4

Beets.—Red beets, given the same cultural and irrigation treatment as the potatoes and corn, yielded the following partial results on a plat containing one-twelfth of an acre:

Yield of irrigated and unirrigated beets at Corvallis, Oreg., 1908.

Treatment.	Yield per acre.	Increase.
	Pounds.	*Per cent.*
Unirrigated	2,725	
Irrigated once	4,309	58.1

Clover.—Duplicate plats of second-year clover containing 1.12 acres each were made the subjects of experiment under irrigation, both being given the same treatment except as to irrigation. The clover was planted in March, 1907, with wheat. The clover gave no yield in 1907, but was in bearing in 1908. The first crop of clover was not irrigated, water being applied to the second crop only. The watering of the irrigated plat was begun on July 23, but was not completed at that time owing to a breakdown of the pumping plant, which delayed the completion of the irrigation till August 9. Had it been possible to complete the irrigation at the time the water was first applied, a much heavier crop would have been cut from the irrigated plat. The yields from the plats were as follows:

Yield of irrigated and unirrigated clover at Corvallis, Oreg., 1908.

Crop.	Unirrigated plat, yield per acre.	Irrigated plat, yield per acre.	Increase.
	Tons.	*Tons.*	*Per cent.*
First crop	4.44	4.44	
Second crop	.63	2.02	220.6
Total	5.07	6.46	27.4

It is unfortunate that more comprehensive and detailed results can not be presented from the Corvallis station for the season of 1908, but the adverse conditions encountered absolutely prevented. Even under these circumstances, however, some results were secured which show unmistakably that irrigation can be made of immense benefit to crops that extend their growth through the summer.

RESULTS IN 1909.

The crops raised in 1909 were potatoes, sweet corn, field corn, Kafir corn, alfalfa, clover, beets, and kale—no reports are available, however, on the Kafir corn, beets, and kale. The land before being seeded was plowed and harrowed, then leveled for irrigation, after which it was disked and then given a final harrowing. The cultivated crops were given five cultivations during the season on the following

dates: June 12, June 21, July 8, July 15, August 5. Crops showed no need of moisture until about July 20. All the crops were given a heavy irrigation between July 22 and July 26, which application under the circumstances was sufficient to carry them to maturity.

The results secured from the various crops, are as follows:

Corn.—A plat of 0.25 acre was planted to Hendricks Early field corn on May 5. It was irrigated once on July 22, water to a depth of 0.65 foot being applied. Part of the plat was planted thin while another was planted thick to determine the effect of thin and thick planting. The following table compares the yields from this plat with a similar plat that received no irrigation:

Yield of irrigated and unirrigated corn at Corvallis, Oreg., 1909.

Treatment.	Green fodder per acre.	Increase.
	Pounds	*Per cent.*
Thick planted:		
Unirrigated	11,125	
Irrigated	14,153	26
Thin planted:		
Unirrigated	11,006	
Irrigated	11,895	8

Potatoes.—A plat containing 0.592 acre was planted to Burbank potatoes on May 3. It was irrigated July 23, water to a depth of 0.54 foot being applied. When the crop was harvested, on October 24, the potatoes were of good size but showed scab and second growth. The yield was as follows:

Yield of irrigated and unirrigated potatoes at Corvallis, Oreg., 1909.

Treatment.	Yield per acre.	Increase.
	Bushels.	*Per cent.*
Unirrigated	150	
Irrigated	215	43

Sweet corn.—A plat containing 0.124 acre of Early Minnesota sweet corn was planted May 5. It was irrigated once on July 22, water to a depth of 0.65 foot being applied. It received the same cultivation as the field corn and potatoes. The yield, compared with a similar plat not irrigated, is shown in the following table:

Yield of irrigated and unirrigated sweet corn at Corvallis, Oreg., 1909.

Treatment.	Yield of fodder per acre.	Increase.
	Pounds.	*Per cent.*
Unirrigated	7,000	
Irrigated	13,750	96

A plat containing 0.124 acre was also planted to Stowell Evergreen sweet corn. This received the same cultural treatment and the same amount of water as the Early Minnesota. The yield of this variety on the unirrigated plat compared with that on the irrigated plat is as follows:

Yield of irrigated and unirrigated sweet corn at Corvallis, Oreg., 1909.

Treatment.	Yield of fodder per acre	Decrease.
	Pounds.	*Per cent.*
Unirrigated	10,936	
Irrigated	10,726	2

Clover.—A plat containing 0.95 acre was planted to a mixture of red clover and alsike clover, on May 14, 7 pounds of red clover and 3 pounds of alsike being used per acre. Water was applied July 24 and 25 to a depth of 0.69 foot. The growth after this irrigation was very rapid and most marked in contrast with the plat not irrigated. The clover on the unirrigated plat after it reached a height of about 4 inches made no further growth during the entire season. On the other hand the irrigated plat grew vigorously and on August 16 was high enough to cut with the mower, on which date 1,333 pounds of green clover was taken off. It revived quickly after this cutting and went into the fall in far better condition than the unirrigated plat. The first year of course is not a fair test with clover for it does not come into full bearing until its second year. With the good start that it has, however, it may be expected that this plat will make a splendid showing the coming season.

Alfalfa.—A plat containing 1 acre was planted to alfalfa and given the same amount of water as the clover. No crop was harvested, however, as it was simply clipped at intervals during the season in order to secure a good stand for coming seasons. A splendid growth was secured and this plat promises well for the future.

EXPERIMENTS IN COOPERATION WITH G. R. BAGLEY, NEAR HILLSBORO.

The tract upon which these experiments were conducted is located about 6 miles north of Hillsboro. Prior to the purchase of the tract by Mr. Bagley in 1906, the land had for many years been used exclusively for grain growing. It is now being developed as a diversified farm, and irrigation, which is easily and cheaply provided, is being employed in its development. A dairy herd is being kept on the property, so that a practical test of the value of irrigation has been possible.

The soil is representative of the prairie soils common to the north end of the valley and may be classed with the gray clay loams. On wetting it becomes a very dark gray in color and is quite sticky. It takes water readily and subirrigates for long distances, making it an easy soil to irrigate. On the farm of Mr. N. H. Campbell, which adjoins the Bagley farm and where irrigation has been tried also, water has subirrigated laterally from a head ditch across a plowed field, a measured distance of over 120 feet. Such a condition as this is very exceptional, even in the most favored irrigated sections of the West.

Water for irrigation on the Bagley farm is secured from Dairy Creek through an old mill race which is part of the property owned by Mr. Bagley. In applying the water to the parts of the farm that were irrigated, both gravity flow and pumping were resorted to. The 8-acre tract upon which experiments with red clover were made is irrigated by gravity flow through a small ditch taken out of the forebay just above the mill. Owing to the mill race being located on the lowest level of the farm, it is not possible to supply much of an area with this water by direct gravity flow. To increase the irrigated area an 8-inch horizontal centrifugal pump was installed in the mill, the water being taken into the pump directly from the penstock. The power for driving the pump was taken from the main line shaft of the mill, which is belt connected to a turbine wheel which operates under 14-foot head and is capable of developing 45 horsepower. The discharge pipe from the pump is taken to a valve chamber outside the mill, from which two lines of pipe can supply the entire farm. One of these lines of pipe, the length of which is 1,760 feet, was laid in 1908. It is a 6-inch, machine-banded, first-grade pipe. The other line has not yet been laid, but the connections for it were all installed at the time the 6-inch line was put in. It will be about the same length, but will have a diameter of 10 inches in order to serve the larger area under it. The 6-inch line serves an area of 30 acres, while the 10-inch line will serve an area of about 70 acres.

The capacity of the line, with the pump running up to a speed of 600 revolutions, is 400 gallons per minute. The capacity of the 10-inch line when installed will be about twice this amount.

RESULTS IN 1908.

It was planned to experiment with corn, kale, beets, turnips, and cucumbers on the tract supplied with pumped water, but owing to damage done by the killing frost in September, no definite results can be reported for these crops. It will be possible, however, to give some partial results showing the benefit derived from irrigation. In addition to these crops, experiments were also made with alfalfa and with clover under irrigation. The frost did no serious damage to these and complete results can be reported.

Corn.—Five acres of field corn were planted June 15 to 20. It should have been planted at least two weeks earlier, but the late spring rains prevented an earlier preparation of the land. With this late seeding, however, a good rapid growth was secured, and even though it was behind most of the corn on neighboring farms in its early stages, it soon caught up in its growth during the latter part of July when the weather became very hot. Water was first applied July 16, when the corn stood about 2 feet high. The effect of this first irrigation was most noticeable during the hot spell that immediately followed. Corn in other sections of the valley was plainly suffering from the heat and from lack of moisture, as indicated by the curling leaves. The irrigated corn showed not only increased vigor during the hot weather, but soon gained the ground it had lost due to late planting. A second irrigation was begun August 9, and enough water was applied to bring the total up to approximately 8 inches in depth. After this no more water was applied. The corn grew rapidly, and by September 1 had attained an average height of between 6 and 7 feet. A good yield seemed assured, the ears developing uniformly and being of good size and quality, but just as it was passing out of the milk stage the heavy frosts of September 23 to 25 stopped all further growth. Although yet immature, even for silage, it was cut and placed in the silo. The yield of the crop as harvested under these conditions was 8,000 pounds per acre. This, however, is much below the actual weight of green fodder produced, because the effects of the frost and subsequent wilting reduced the weight very materially.

Kale.—Three acres of "Thousand headed" kale were planted from the seed at the same time the corn just mentioned was planted. It was also given the same cultural treatment. This crop was of course not hurt by the frost. The yield was 30 tons per acre. This is not a large yield, but the beneficial effect of irrigation on the kale plants themselves in their younger stages was most marked.

Beets.—One acre of mangel wurzels was planted at the same time as the corn and kale. A very poor stand was secured, however, and the growth, like that of the corn, was checked by the frost. The yield of beets from the 1 acre was 12 tons. This yield, however, does not thoroughly indicate the effect of the water used in irrigation, for the benefit they derived was most marked. Much of the seed, owing to the dry spring weather, did not germinate until after the first irrigation, and these beets, it will be realized, could not make much of a growth. The seed that did germinate in proper season produced large, well-formed beets which with the assistance of the water attained their full size despite late planting.

Cucumbers.—One-fourth of an acre was planted to pickling cucumbers. These showed a splendid growth throughout the entire season.

The beneficial effect of irrigation was most noticeable in that a thrifty growth was maintained during the entire dry season. The vines were just in their prime when the frost killed them. The yield from the one-fourth acre plat was 2 tons.

Beans.—One acre was planted to little white navy beans that also showed a splendid growth under irrigation, but these, too, were killed by the frost just as the pods were beginning to ripen.

Alfalfa.—Realizing from the results of the experiments of 1907 that one of the greatest benefits to be derived from irrigation was in the production of leguminous forage crops, an experiment in the production of alfalfa under irrigation was begun. Alfalfa is not an easy crop to raise in the Willamette Valley on account of the difficulty of getting it started successfully. It is being raised, however, in certain sections of the valley with marked success. At the State Experiment Station at Corvallis, for instance, there is an alfalfa field 7 years old which produces splendidly, yielding 5 tons of hay per acre on the average. The greatest difficulty is experienced in most cases, however, in securing a stand, and the numerous failures have developed the erroneous idea that alfalfa can not be raised in the Willamette Valley. A variety of reasons may be assigned for these failures, among which the most important seem to be: (1) Improper and insufficient artificial inoculation of the soil with nitrifying bacteria, the Willamette soils generally being sterile in this regard; (2) poor preparation of the seed bed; (3) poor selection of soil, which should be light in texture and well drained; (4) planting of varieties of seed not adapted to soil and climatic conditions of the Willamette Valley; and (5) drying out of the soil during the dry summer season, which not only stunts the growth of the young plant, but actually kills it before it can gain a sufficient root hold.

The seed which has been tried in the valley has come largely from Utah. Some of this has been successful, but it does not seem to be adapted to local conditions, and most of it has failed. With a view to trying a variety more adapted to Willamette conditions, a small amount of seed of what is known as Arabian alfalfa was secured from the Bureau of Plant Industry. This variety, as its name implies, had its origin in Arabia. It is claimed that its growth is more vigorous than that of the ordinary variety, that it recovers quickly after cutting and that its growing season is much longer than that of the ordinary variety, commencing earlier in the spring and continuing later in the fall. It has shown in actual tests its ability to produce three cuttings in sixty days, where under the same conditions the ordinary variety produced but two.

Enough seed was secured to plant one-half acre. A duplicate plat was planted with Utah seed for sake of comparison. The land was subsoiled and thoroughly worked before seeding and was inoculated

with old alfalfa soil secured from the State Experiment Station farm at Corvallis, about 400 pounds of alfalfa soil being applied to the two one-half acre plats. The seed of both varieties was planted on May 30. The Arabian seed came up quite evenly, while the Utah seed was more or less spotted. On July 15 the Arabian plants showed an average height of 8 inches, with some plants around the edge of the plat 1 foot high. The Utah plants on the same date stood from 2 to 3 inches high in the best spots, the stand being very uneven. The Arabian alfalfa was clipped with the mower at this time and the first irrigation applied to both plats. From this time on the vigorous growth of the Arabian variety was most marked. The Utah alfalfa seemed slow to gather its strength and required the whole summer season for growth before it was high enough to clip with the mower. On the other hand, the Arabian variety after the first clipping and irrigation recovered rapidly and in another month had reached an average height of 10 inches and was again clipped and irrigated. By the middle of September it was ready for the mower again, and this time there was saved from the one-half acre plat 1 ton of green fodder. After this last clipping it revived quickly and went into the winter season with a growth of 8 inches. Eight inches of water was applied to each plat. That this irrigation was the means of producing the splendid growth was plainly evident. The vigorous growth of the young plants of both varieties was maintained throughout the dry season, where without water they would have suffered for moisture just at the time they most required it.

In January a prolonged spell of unusually cold weather was experienced in western Oregon, and in the vicinity of Hillsboro the thermometer dropped to 8° and 10° F. below zero. With no snow to protect the young alfalfa plants, the ground was subject to a heavy freeze which killed out the plat of Arabian alfalfa completely. The Utah alfalfa, on the other hand, although it winterkilled to some extent, withstood the freezing better and came through the winter in much better condition. It is evident from this experience, therefore, that the Arabian variety can not stand cold weather, and, although the temperatures which killed it were very exceptional for this region, it nevertheless would be a poor variety to depend upon unless subsequent investigation shows it to be more hardy as the plants grow older. No effort was made to replant the alfalfa in 1909.

Clover.—The experiment with clover was made on the 8-acre tract that was irrigated by gravity from the mill pond. The results secured from this tract are perhaps the most striking and at the same time the most conclusive of any of the experimental results secured during the investigation. They indicate beyond a doubt the great value of irrigation in the production of leguminous forage crops, and

show that by the application of water during the summer time to such crops as clover the producing value of such land as that experimented upon can be at least doubled at a very slight expenditure of money and labor.

The tract, prior to the time it was planted to clover, had for a number of years been cropped to grain and, like all grain lands of the valley, had a heavy plow sole at a depth of about 6 inches. In the fall of 1906 it was plowed 10 inches deep with an ordinary walking plow, and then subsoiled to an additional depth of 8 inches so as to thoroughly stir the soil and break up the plow sole. After being plowed and harrowed it was seeded to winter vetch and oats on November 24. In February, 1907, red clover was sowed on the vetch and oats. The vetch and oats were cut July 5, and from the appearance of the ground the stand of clover seemed to be very poor, only a few sickly and weak plants appearing. The soil was drying out rapidly, and had there been no opportunity to irrigate the tract it would have been impossible to secure a stand of clover. The tract was given a thorough irrigation as soon as the vetch hay was taken off, with the result that the clover began to grow vigorously. By August 15 it was high enough to cut with the mower, and on that date Mr. Bagley began soiling the crop for the cows. The soiling was continued during the remaining half of August, all of September, all of October, and part of November, and upon more than half the tract a second cutting of clover was secured. As to the yield from the tract in 1907, Mr. Bagley says:

I had no means of securing accurate weights of the crops removed from the tract during the year 1907, but estimated that I secured 20 tons of vetch hay, 100 tons of green clover, 4½ tons of clover hay, and 8 tons of clover silage, and a stand of clover from 6 to 10 inches high which will make excellent mulch. This is the first instance within my knowledge or within the knowledge of any of the farmers of this community that a crop of clover was produced in the year it was seeded; in this instance two crops of clover were produced the year it was seeded, a portion of which was used for silage.

Reducing the estimated yield to an acreage basis, the 1907 crop may be expressed as follows:

Acreage yield of vetch hay and clover under irrigation.

	Tons.
Vetch and oat hay	2.5
Green clover fodder	12.5
Dry clover hay	.5
Clover silage	1.0
Winter mulch, 6 to 10 inches.	

The land was not pastured either in the fall of 1907 or in the spring, as is commonly done in Washington County, with the result that an early spring growth was secured. On May 6 the crop was ready for the mower, and on that date soiling began. The clover was fed to

the milk cows and the hogs as it came from the field, two or three swaths being cut each night and morning for this purpose. By the time the whole field had been cut over in this manner, the clover on the side of the field cut first was ready for the second cutting. The crop was soiled in this way from May 6 to October 10, a period of five months, and during this time four full cuttings in the blossom were taken from the tract. During the first and second cuttings the clover matured faster than the stock could consume it and a part of these cuttings was cured for hay.

The field was irrigated from a gravity ditch out of the mill pond, the same as in 1907. Water was first applied on July 14, the water being used at night mostly, when the mill was not in operation. A second irrigation was given beginning on August 9 and a third beginning September 1. An accurate measurement of the total water applied could not be made, owing to the fluctuation in head available, but an approximate estimate of the water applied would place the total amount at 1 acre-foot per acre. The aggregate time required for each irrigation did not exceed three days.

Based upon actual weight, there were removed from the 8 acres during the five months' cropping season 195 tons of green clover fodder and 7½ tons of dry clover hay. Reducing the green clover yield to a cured hay equivalent, using the ratio of 4 to 1,[a] the total yield of the tract in cured clover hay may be stated as 56.25 tons, which is a yield of 7.03 tons per acre. To emphasize just what this yield means as an argument in favor of irrigation, reference will be made to the yields secured the past season on four of the best cared for clover fields in Washington County. The yields given are based upon statements made by the owners.

Adam Bender.—Area of field, 7.5 acres. Soil well fertilized with manure. Yield, first crop, 3 tons per acre. Yield, second crop, 2.5 acres gave 1 ton of hay per acre; 2.5 acres cut for seed that yielded 325 pounds per acre; the remaining 2.5 acres were pastured.

Herman Kamna.—Area of field, 10 acres. Yield, first crop, 3.5 tons per acre. No second crop was cut, the field being pastured.

Jacob Milne.—Area of field, 60 acres. Yield, first crop, 3.5 tons per acre. No second crop was cut, field being pastured.

F. R. Davis.—Area of field, 80 acres. Yield, first crop, 3 tons per acre. Second crop on 40 acres was cut for seed that yielded 200 pounds per acre. The remaining 40 acres yielded no crop, field being pastured.

It is common practice in raising clover to delay cutting the first crop until after July 4, by which time all danger of damage from rains is usually past. Under this practice it is impossible to secure subse-

[a] Johnson, How Crops Grow, pp. 39, 40.

quent crops, owing to the dry season coming on and preventing further growth. Some of the more successful growers, by cutting their first crop before July 1, are able to get a small second crop for seed, but the majority usually pasture their clover fields the remainder of the season after the crop is taken off and make no effort to get a further growth. Under existing conditions the three best months in the year—July, August, and September—can not be made use of in the production of hay, for the fields lie practically dormant during this period, waiting for the early fall rains to moisten the soil and revive the growth of the plants. All through the dry summer months, when the clover in other fields stood only 2 to 3 inches high and was parched and brown, the irrigated clover on the Bagley farm maintained its vigor and grew rapidly, piling up its yield until at the end of the season it had produced more clover than any other field of twice its size in the county or in the valley.

Not only was irrigation responsible for this greatly increased yield of clover, but it produced also quite as important a result in providing green fodder throughout the dry season for the dairy herd and other animals on the farm. With the exception of a little chop feed given the dairy herd, this 8-acre tract produced in 1908 the entire food supply for 20 head of milch cows, 60 head of hogs, and 2 horses for the five-month period from May 6 to October 10, and in addition produced 7 tons of dry hay.

RESULTS IN 1909.

Heavy and well distributed local showers occurring during May, June, and during the first week in July postponed the regular droughty period until well along in July. Aside from this, normal conditions prevailed. The crops experimented upon were corn, potatoes, turnips, and clover.

Corn.—Five and one-half acres of corn for ensilage were planted May 20. Poor seed had been secured, so that the stand was very uneven. A good growth was secured, nevertheless, and with favorable weather during May and June a fair stand of corn was obtained. The crop was given but one irrigation, water to a depth of 4 inches being applied August 2 and 3. Another irrigation could have been applied with benefit, but a scarcity of labor prevented.

The corn was cut and put into the silo the first week in October. The total yield of green fodder was 693,000 pounds, which was equivalent to an acreage yield of 12,600 pounds.

Potatoes.—A plat containing three-fourths of an acre was planted to Burbank potatoes on May 12, and a splendid stand secured. Potatoes were given two irrigations, one July 31, when the tubers were about the size of a hen's egg, and another on August 16. A

depth of 6 inches was applied the first irrigation, and a depth of 4 inches was applied at the second. This amount of water, together with the rainfall previously received, seemed to give the best results. The yield from 0.75 acre was 183 bushels of marketable tubers. The yield per acre on this basis was 244 bushels. The potato crop in other parts of the county was extremely light, the tubers being very small, with only a small percentage of good marketable size and quality.

Turnips.—No returns can be given for the turnips, as they are still in the ground at the time this report is being written, it being the practice to feed turnips directly from the field throughout the winter.

Clover.—The experiment on the 8-acre clover tract was continued in 1909. In the production of clover where irrigation is not practiced it is practically impossible to secure paying yields after the second season of bearing. The land becomes so foul with grass and weeds that the clover is crowded out and reseeding is required. This was the third successful bearing season for the 8-acre tract in question, and the results secured, although they were not what they might have been, show most conclusively the benefit to be derived from irrigating clover.

As the land was not pastured in the fall of 1908 or the following spring, an early growth was secured, and the clover was ready to cut by May 1. Soiling was commenced on May 3, and two complete cuttings in the blossom were secured by July 14. One irrigation was applied June 15, when the first crop had been taken off, and another should have been applied about July 15, when the second cutting was completed, but a rainfall of 2 inches on July 4 and 5 revived the crop to such an extent that it was thought the second watering could be dispensed with. That this rainfall was entirely insufficient to meet the needs of the crop was later demonstrated. Instead of growing rapidly after the second cutting was taken off, the clover, while it remained green, made no considerable growth, and as a result the third crop was much delayed. Realizing that a thorough wetting was necessary, the tract was irrigated on August 1. The clover at once began to make a good growth, and by August 22 was ready for the mower, and the third cutting was begun and continued until September 15.

There was taken from the 8 acres during the season of 1909, 145 tons of green clover fodder, and during the first and second cuttings there was an excess that the dairy herd did not consume, that was cured for hay, the weight of which was 6 tons. On a dry-hay basis the yield of the tract was, therefore, 5.3 tons per acre, which was about double the yield secured from clover fields elsewhere that were not irrigated.

The yield of the tract for the season, owing to the delay in the third cutting, was not what it might have been and fell considerably below the yield of 1908. It was, however, much in excess of other clover fields in the county, and as it was the third season in bearing for this tract the results secured were most unusual.

EXPERIMENTS IN COOPERATION WITH COCKERLINE AND HOWARD, NEAR ALBANY, OREG.

The experiments in cooperation with Cockerline and Howard were made upon a 70-acre tract located 1 mile south of Albany, in Linn County, to determine the value of both irrigation and drainage in bringing back to a state of productiveness land which will no longer respond readily to cultivation, owing to the poor physical and chemical condition of the soil resulting from inadequate drainage and long-continued shallow cultivation.

SOILS.

The surface soil, which varies from 18 inches to 2 feet in depth, is a heavy clay loam. The subsoil is a yellow clay. There are two depressions on the tract in which "white land" occurs. This white land, so called because of its color, is the product of bad drainage and results from the continued leaching of gray clay loams. In its natural condition it is very hard to cultivate and practically valueless as crop-producing land. When properly underdrained, however, and given good cultivation, it has been found to take on a darker color and become more loose and friable.

DRAINAGE.

With a view to determining the value of thorough underdrainage on this class of soils, a tile-drainage system was installed by this Office during the winter of 1907 and 1908 to relieve the soil of its excess of water during the rainy season. By thus removing the water as fast as it falls on the land, water logging can be entirely prevented and the soil kept in good condition for early cultivation in the spring. The drains have been in operation but two seasons and their full effect can not yet be determined. Their behavior thus far, however, indicates that they are serving their purpose admirably and that in due time they will aid materially in bringing back to a producing condition land which heretofore had been deteriorating steadily with each season's water logging. Two thousand feet of tile, varying from 3 inches to 10 inches in diameter, were laid on a little more than 60 acres at a cost of approximately $20 per acre.

CULTIVATION.

In the spring of 1908, after the work of laying tile had been finished, the entire area provided with underdrainage was plowed and subsoiled, the land being plowed to a depth of 8 inches with an ordinary walking plow and then subsoiled an additional 8 inches in depth with a subsoiler. This deep cultivation has destroyed the heavy plow sole that existed and put the surface soil into intimate relation with the subsoil, thereby establishing the right conditions for good drainage and proper aeration of the soil.

IRRIGATION.

Through the courtesy of the Willamette Water Company, it is possible to secure water for irrigation by gravity flow from their power canal which flows through the property. Little opportunity has as yet been afforded to determine the value of irrigation as an aid to the growth of forage crops during the dry season for the reason that none of the forage crops planted last season have reached a stage where water can be applied with benefit. Partial experiment the past season has indicated that it is unwise to water field crops on this type of soil until they have reached a stage where they can shade the ground and prevent baking and the plants are vigorous enough to withstand such baking as occurs. The value of irrigation on cultivated crops was demonstrated satisfactorily.

CROPS.

To build up the humus in the soil and to increase the nitrogen content, both of which are very deficient, it was decided that as rapidly as possible the tract should be put into leguminous crops. Seventeen acres on the best naturally drained part of the tract was planted two years ago to alsike clover. It had so nearly run out, however, that after it had produced a crop of seed in 1909 no further growth could be secured by the application of water.

Red clover.—Twenty-three acres were planted to red clover in the spring of 1909. The subsoiling and preparation of the land delayed the planting until June 1, which was so late in the season that no stand was secured. Most of the seed remained in the dry soil during the entire season without germinating. An effort was made to "irrigate the seed up" on a part of the area, but without success. The surface soil ran together and baked and stifled the growth of the young plants. It seems almost certain that on land of this character irrigation will be of benefit only after the crop is in good growing condition and is able to withstand the baking that must always occur where cultivation can not be resorted to or where the crop is not high enough to shade and protect the soil from the sun.

RESULTS IN 1908.

Field peas.—Fourteen acres of the poorest land were planted to Blue Prussian field peas for green manuring purposes. These were planted late also, but a good stand was secured. Owing to the location of the supply ditch, only 4 acres of this area could be irrigated. Water was applied August 3, with the result that a much heavier growth was secured than on the unirrigated area. As all the peas were plowed under for green manure, no estimate of the yield can be given. It seems safe, however, to estimate the increase in green matter due to irrigation at 75 per cent. The peas matured on both the irrigated and unirrigated areas before they were plowed under, and with the aid of the early fall rains gave a second crop, which grew well up to the first of the year, when vetch was seeded with the peas for the coming season's growth.

Cultivated crops.—Eight acres were prepared for furrow and cultivated crops, corn, beans, pumpkins, and potatoes being planted. Like the crops on the other stations, these crops were laid low by the frosts in the latter part of September, and their full development cut short. Partial yields, however, were secured, which are worthy of consideration, especially when it is remembered that the soil upon which they were produced is classed as "worn-out."

But one irrigation was given the cultivated crops, and that began on July 30. Approximately 6 inches of water was applied in this one irrigation. From the behavior of the crops both before and after irrigation, it is evident that the water should have been applied much earlier. Crops in the Willamette Valley do not show the effects of drought as they do in the arid sections, and it is very difficult to determine just when water should be applied.

Corn.—A plat containing 2 acres was planted to field corn on June 6. Both a good stand and a good growth were secured, although a better growth would have resulted had the plat been irrigated earlier, as suggested above. Thorough cultivation was given both before and after irrigation. The total yield of green fodder from the 2 acres was 34,000 pounds, which is equivalent to 17,000 pounds per acre.

Beans.—A plat of 1 acre was planted to small white navy beans on June 8. Of all the crops planted, these showed themselves by vigorous growth the best adapted to present soil conditions. The yield promised to be a heavy one, all pods being well filled. The frosts killed the vines, however, before the beans had an opportunity to ripen, so that no crop was secured. The beneficial effect of irrigation on the beans was most noticeable.

Pumpkins.—One acre was planted to pumpkins on June 8. These, like all other crops, were caught by the frost when only about 60

per cent of the crop had matured. Twenty-five loads, averaging 1,500 pounds per load, were taken from the plat. Five loads, not being matured, were unsalable. The total yield from the 1 acre was 37,500 pounds. Much more than this could have been secured had the immature pumpkins had opportunity to ripen. In the case of this crop the effect of the one irrigation was also very noticeable.

Potatoes.—Two plats of potatoes were planted on June 11. One of the plats, containing 1 acre, was not irrigated; the other, containing 2 acres, was irrigated once in the same manner as the crops already discussed. Frost damaged these also, killing the vines before many of the tubers had reached their full development. From the 1-acre unirrigated plat, 68 bushels of marketable tubers were dug, while the 2-acre irrigated plat produced 231 bushels of marketable tubers. Not only did the irrigated potatoes show this increase of 70 per cent in yield, but the tubers themselves were larger and of a better quality than those from the unirrigated plat.

RESULTS IN 1909.

The failure to secure a stand of clover in 1908 made it impossible to make any experiments with the irrigation of forage crops in 1909. The experiments of 1909 were therefore confined to irrigation of cultivated crops, to the production of which 12 acres were devoted. The crops planted were corn, beans, pumpkins, potatoes, and squash. Two irrigations were applied to all crops except the beans, which were given but one, the experience of the year previous showing that if this crop is given too much water there is an excessive growth of foliage and the ripening of the bean is delayed to such an extent that early fall frosts are apt to cause damage before maturity. Water to a depth of 6 inches was applied at each irrigation.

Corn.—A plat of 1 acre was planted to corn May 16. When the corn was about 4 inches high cutworms destroyed practically the entire stand. A replanting was also destroyed when it had reached about the same stage, so that no crop was secured and no results can be reported for 1909.

Beans.—A plat of 2 acres was planted to white navy beans on May 18. Like the beans planted the previous season, they made a splendid growth and showed their adaptability to the heavy clay soil. They were irrigated once, June 17, 6 inches of water being applied. The crop matured fairly well and was pulled the last week in September, the vines being piled in the field to allow further ripening. Heavy rains just at that time, however, damaged all the beans that were not fully matured and the yield in marketable beans was materially decreased as a consequence. From the 2 acres, 1,250 pounds of marketable beans were thrashed, which, although not a heavy yield, gave a good return from land in such poor condition.

Pumpkins.—One acre was planted to pumpkins May 17. Two irrigations of 6 inches each were applied July 18 and August 4. A good growth and a good yield were secured, the 1-acre plat producing 10 tons of marketable pumpkins, which were sold to dairymen for one-half cent a pound in the field. This is another crop that seems to do very well on the heavy clay soil if given sufficient moisture during the dry season.

Potatoes.—In view of the success of the previous season, 6 acres were planted to potatoes. These were given two irrigations, also, one of 6 inches on June 18 and 19 and one of 6 inches on August 5 and 6. The 6 acres produced 1,014 bushels, which was at the rate of 159 bushels per acre. This is not a heavy yield for potatoes, of course, but when the condition of the soil is taken into account and when it is also considered that potatoes as a general crop throughout the valley in 1909 were largely a failure, the yield secured may be taken as showing the value of irrigation even where the soil is not exactly adapted to it.

Squash.—The plat of 1.5 acres of squash was planted May 16. Two 6-inch irrigations were applied, one on June 23 and one on August 7. These produced even better than the pumpkins, and gave a yield of 12 tons per acre. The value of irrigation on this crop was also most marked, showing that where water is available for irrigation squash can be employed profitably in a scheme of crop rotation designed to bring the worn land back to its original condition.

EXPERIMENTS ON THE HOP YARD OF OSWALD WEST, NEAR CORVALLIS, OREG.

The Willamette Valley produces about one-eighth of the hop crop of the world. This crop is therefore one of the important products of the valley. Production is confined almost entirely to the bottom lands along the river and to sections where the soil is naturally moist.

The yard upon which these experiments were made is located on Kiger's Island, 3 miles south of Corvallis. The soil is a sedimentary deposit of fine silt underlaid by a porous gravelly stratum and dries out to such an extent that the hops, especially those on the higher elevations, suffer from lack of moisture. The equipment for the irrigation of the yard consisted of a 6-horsepower portable engine and a 4-inch centrifugal pump. Water was lifted 25 feet and discharged into a flume 800 feet long, which conveyed it to the yard. The plant was installed about the middle of July, 1907. In reporting the experiment Mr. West says:

In 1906 the yard produced, without irrigation, about 800 pounds per acre, which is a little less than an average yield for yards in the Willamette Valley; many yards on the river bottoms yield, however, a ton to the acre, and even more. In 1907 less than

one-half of my 25-acre yard was irrigated and only for a period of about fifteen days in July and August. The yard was irrigated from the Willamette River with a 4-inch pump and a 6-horsepower gasoline engine. About 150 gallons of distillate were used for fuel, which cost 11.5 cents per gallon. One man was able to look after the engine and pump and do the ditching, which was done with a plow. The yield from the entire yard averaged 1,150 pounds per acre, which would mean about 80 per cent increase, as the crop on the unirrigated part of the yard was about the same as it was the preceding year, except that portions of it may have derived benefit through subirrigation, which might have increased the yield.

The results have shown that irrigation can be carried on successfully in the Willamette Valley, and on places situated similar to mine can be conducted at very little cost; also that the yield can be increased at least from 75 per cent to 100 per cent. I hope eventually to have the whole place, 150 acres, under irrigation.

The experiments were continued in 1908, one-half of the yard, 12½ acres, being irrigated. The remaining half was not watered, because the plant did not have sufficient capacity to supply the entire 25 acres. Water was applied August 1 to 10, but no record was kept of the amount applied. When the crop was picked, the 12½ acres not irrigated gave a yield of 750 pounds per acre, while the 12½ acres that were irrigated gave a yield of 1,500 pounds per acre, showing an increase in yield due to irrigation of 100 per cent.

This experiment shows that irrigation can be used to great advantage in the production of hops, especially where the yard is located on upland or on porous gravelly bottom land. It serves not only as valuable crop insurance during seasons of scanty rainfall, but greatly increases the normal production.

EXPERIMENTS ON THE MARKET GARDEN OF ROBERT GALLATLY, NEAR PHILOMATH, OREG.

The purpose of the experiment on the market garden of Robert Gallatly, near Philomath, was to determine the value of irrigation in the production of onions. For market gardens and for the raising of vegetables in general, irrigation is without doubt of great value. This has already been demonstrated in the market gardens throughout the valley. To produce the first crop of vegetables, especially the early-maturing varieties, irrigation is not necessary if sufficient cultivation is given. For a second and later crop of vegetables, however, and for such slow-growing crops as celery and cauliflower, irrigation eliminates all possibility of damage from drought and produces, even in average seasons, better results than are secured by dependence upon natural rainfall.

Mr. Gallatly has for a number of years raised vegetables under irrigation. The 2-acre tract devoted to the experiment is a rich creek-bottom loam which absorbs water readily. Water is obtained from a small creek by gravity flow and the amount applied to the onions experimented upon was measured over a weir. In making the test

it was arranged to leave a part of the onion patch unirrigated, twenty-four rows, each 60 feet in length, being set apart for this purpose. The entire patch included an area of 10,000 square feet. The rows were spaced 1 foot apart and water was applied to each row from a head ditch. The crop was given four irrigations during the season, water being applied as follows.

Depth of water applied to onions at Philomath, Oreg.

	Feet.
First irrigation	0.79
Second irrigation, June 20-22	1.23
Third irrigation, July 12	.73
Fourth irrigation, July 23-26	.76
Total for season	3.51

In irrigating, much more water was applied than was absorbed by the soil, the excess passing off to other parts of the garden and also wasting into the creek. There was no way of determining the amount of this excess, but it is safe to assume that three-fourths of the amount applied passed off as waste.

The 24 rows that were not irrigated showed a marked contrast to the irrigated rows by the time the second watering was given. These rows did not have the color or the size of the irrigated rows and clearly showed the need of moisture. It was not possible to do away entirely with subirrigation on the unirrigated rows, but the difference in yield between the irrigated and unirrigated onions very clearly indicated the value of irrigation when the moisture in the soil is deficient. When the onions were harvested, 24 representative rows were selected from the irrigated area for comparison with the 24 unirrigated rows.

The results were as follows:

Yield of irrigated and unirrigated onions, Philomath, Oreg.

	Pounds.
Yield from 24 irrigated rows	850
Yield from 24 unirrigated rows	350
Increase	500

On an acreage basis, the yield was as follows:

	Pounds.
Yield per acre, irrigated	25,700
Yield per acre, unirrigated	10,587
Increase	15,113

Not only was there this increase in yield, but there was a marked difference in both size and quality in favor of the irrigated onions. The patch, less than one-fourth acre, yielded 150 bushels of onions.

SUMMARY.

The results of the several experiments of the past three seasons are brought together in the following summary. It has not been possible in all cases to compare the yields of the irrigated areas with those of the unirrigated areas. In a number of cases, however, such a comparison is possible, and in these the effect of irrigation is strikingly brought out.

Summary of results from irrigation experiments in Willamette Valley, 1907–1909.

Experimental tract.	Season.	Crop.	Yield.		Increase.
			Unirrigated.	Irrigated.	
			Per acre.	*Per acre.*	*Per cent.*
State experiment station	1907	Corn (green fodder)......pounds	5,647	9,666	71
Do	1908	Corn (green fodder)......do	7,280	[a] 9,640	32
Do	1909	Corn (green fodder)......do	11,125	14,153	36
Do	1909	Corn (sweet corn)......do	7,000	13,750	96
Bagley farm	1908	Corn (green fodder)......do	....	[a] 18,000	....
Do	1909	Corn......do	....	12,600	....
Cockerline and Howard farm	1908	Corn......do	....	[a] 17,000	....
State experiment station	1907	Potatoes......bushels	43	125	180
Do	1908	Potatoes......do	60	[a] 86	39
Do	1909	Potatoes......do	150	215	43
Bagley farm	1909	Potatoes......do	....	244	....
Cockerline and Howard farm	1908	Potatoes......do	68	[a] 115	70
Do	1909	Potatoes......do	....	169	....
State experiment station	1908	Beets (red)......pounds	2,725	4,309	58
Bagley farm	1908	Beets (mangels)......do	....	24,000	....
Gellatly farm	1907	Onions......do	10,590	25,700	143
Cockerline and Howard farm	1908	Pumpkins......do	....	[a] 37,500	....
Do	1909	Pumpkins......do	....	20,000	....
Do	1909	Squash......do	....	24,000	....
Do	1909	Beans (small white navy)......do	....	625	....
West hop yard	1907	Hops......do	640	1,150	80
Do	1908	Hops......do	750	1,500	100
State experiment station	1908	Red clover hay......tons	5.07	[b] 6.46	27
Bagley farm	1907	Red clover hay......do	[c] 3.00	4.70	57
Do	1908	Red clover hay......do	[c] 3.50	7.03	101
Do	1909	Red clover hay......do	[c] 2.50	5.30	112
Do	1908	Kale......do	....	30	....

[a] Damaged by frost.
[b] Water not applied early enough, owing to breakdown of pumping plant.
[c] Yield of representative neighboring fields.

CONCLUSIONS.

The investigations and experiments that have been made have brought out certain facts and warrant certain conclusions, as follows:

IRRIGATION NECESSARY.

The experiments made, though incomplete in many respects, have shown conclusively that great benefit is to be derived from summer irrigation in the Willamette Valley; that through it crops may take advantage of the best growing months of the year, thereby giving not only a more assured return but a greatly increased yield; that without irrigation crops must depend upon the natural rainfall, which is uncertain, and at the best is insufficient in amount to maintain proper soil-moisture conditions.

ALL CROPS BENEFITED BY IRRIGATION.

The benefits of irrigation seem to be confined to no one crop. All crops experimented upon—corn, potatoes, beets, clover, alfalfa, kale, beans, onions, hops, pumpkins, and squash—show a decided increase in yield, also improvement in quality when irrigated. The smallest increase secured from any one crop was over 30 per cent, and in this case the crop was damaged by frost before maturity. The largest increase was nearly 180 per cent. In general, it seems safe to say that the intelligent application of water to crops will easily increase yields from 75 to 150 per cent. In other words, irrigation properly applied will double the output of farming operations.

IRRIGATION OF FORAGE CROPS.

The growing importance of the dairy industry in the Willamette Valley is fast bringing the production of forage crops to be one of the most important phases of farm practice. The climatic conditions during the growing period of these crops are such as to make the fullest development difficult. Owing to the mild, moist spring, most hay crops, if permitted to grow, are ready for cutting toward the first of June, but as a rule a rainy period may be expected about that time, and unless the time of curing be delayed the hay crop is very apt to be damaged while curing. To prevent this and to delay the haying season until more settled weather can be counted upon, the practice of pasturing the crop in its early stages of growth, in March, April, and May, has become quite common. By so doing, however, the growth of a possible second crop is delayed and the dry summer period comes on before the plants can make much headway toward a second crop. As a result, only one good crop of hay is secured, with possibly one light crop following, which is either cut for hay or allowed to produce seed.

Another effect of the dry summer season is to deprive the dairy herd of green food during the very months of the year when it should be the most abundant. Through the balance of the year, by judicious selection of soiling crops, dairy cows can be provided with green food. In the summer time when the pastures are all dried up they must subsist on dry hay and silage. One of the greatest benefits to be derived from irrigation will therefore be in the production of forage crops.

The Hillsboro experiments have shown conclusively that in the case of red clover the yield can easily be increased 100 per cent, and not only is it thus possible to increase the productiveness of the land, but the dairy herd can be provided with green fodder throughout the dry summer by soiling the crop, thus solving one of the most serious problems confronting the dairymen at the present time.

IRRIGATION OF POTATOES.

The benefit of irrigation to potatoes seems to be quite well demonstrated. A question yet to be solved in connection with late-planted potatoes is whether it is best to irrigate before planting or after. The potatoes raised thus far which have been irrigated after planting have shown a slight tendency to be rough coated and subject to second growth unless the water is applied at the right time. As all the potatoes raised were produced on rather heavy land, it is thought this trouble may be due to the heavy soils running together and hindering the proper development of the tuber. One experiment was tried in 1908 in which the soil was irrigated, then plowed and seeded, and no more water given to the crop. The crop was planted the second week in July. The tubers showed neither of the troubles mentioned, and promised a heavy yield up to the time the frost killed the vines and stopped their growth. Just what is the best method of irrigating late planted potatoes remains for future investigation.

IRRIGATION OF CORN.

Irrigation almost doubles the yield of corn fodder. The production of corn fodder, however, is not an important item, since there are other and better forage crops that can be raised. What is needed is a variety of corn that can be ripened successfully under Willamette Valley conditions, the grain to be used for finishing purposes in connection with the production of hogs and beef. The State Experiment Station is now breeding up such a strain of corn, and if these efforts are successful an important problem connected with stock feeding will have been solved. The value of irrigation in the production of ripe corn remains to be determined.

IRRIGATION OF ROOT CROPS.

Root crops can be immensely benefited by irrigation, and as these will form an important part of the production and feeding ration on the diversified farm the value of irrigation in their production can be readily appreciated.

DEEP PLOWING AND SUBSOILING.

There can be no question as to the benefit of deep plowing and subsoiling, especially on land that has been cropped to grain for any length of time. Wherever a heavy resistant plow sole exists subsoiling should be resorted to in order to put the soil in shape for good cultivation. So long as the surface soil remains isolated from the subsoil by such an impervious barrier the producing power of the soil will be limited. Such a loosening of the soil is absolutely essential where irrigation is to be employed, in order that the water applied may percolate properly into the subsoil.

EFFECT OF WATER ON SOILS.

There seems to be a fear on the part of some that irrigation will have a damaging effect on the soil. Their contention is that inasmuch as the soil is saturated during a large part of the year from the heavy rains the tendency to saturate them during the summer under irrigation will give them no chance to "dry out" during the summer season and they will become "sour" and lifeless. This idea is founded on a misconception of what irrigation really means. Land that is intelligently irrigated is not saturated. But on the other hand, just enough water is applied to maintain the proper moisture conditions. Where such a practice is followed no harm can possibly be done to the soil, for with proper drainage the aeration of the soil is in no way interfered with, and so long as this condition is maintained the soil will not become "sour" or lifeless. It is admitted that much damage can be done through ignorance or carelessness on the part of an irrigator or where poor drainage conditions exist, but with careful handling of the water no harmful results need ensue.

EFFECT OF IRRIGATION ON CROPS.

Much the same can be said of the effect of irrigation on crops as has just been said of its effect on the soil. Too much water will damage the crop; this is especially true of fruits. Careful experiment, backed up by the opinions of those who have had much experience in irrigation, proves the fallacy of the contention that crops raised with irrigation are inferior to those raised without it. As in all other farming operations, much depends upon the irrigator himself. If he is careful and painstaking in his work and is guided by a careful study of the conditions that prevail, the results he will accomplish will demonstrate to him that irrigation is but a means of improving natural conditions and that where intelligence and care are used no harmful effects will result to either soil or crop.

WHEN WATER SHOULD BE APPLIED.

Crops in the Willamette Valley do not show the effects of drought, as they do in the arid regions where the evaporation is excessive, and it is a difficult thing to determine just when water should be applied to produce the best results. With the atmosphere never excessively dry, enough moisture, especially in the form of dew, seems to be present to prevent crops wilting or turning color, and instead of showing plainly the need of moisture, as they do in dry climates, their growth seems to be simply suspended until the soil receives water from some source. Under such circumstances, the needs of the plant must be anticipated in the matter of irrigating it and the condition of the soil should be taken as a guide rather than the condition of the

plant. The effect of delaying irrigation was well illustrated by the behavior of the Bagley clover tract in 1909. It was thought that the heavy rainfall early in July would make a second irrigation unnecessary at that time. No water was applied, and as a result the clover practically stood still in its growth, the rainfall received simply offsetting the evaporation. The crop remained green, but made no growth until water was applied.

In general, it seems that irrigation should begin in average years not later than July 1 and regular applications should be made throughout the dry period without reference to showers, which seldom prove to be of material benefit. Cultivated crops, it seems, should have not less than two irrigations, while hay crops will require more.

AMOUNT OF WATER REQUIRED.

It has been impossible to determine with any finality the exact amount of water that should be applied. Measurements that have been made indicate that the average duty of water for all farm crops will approximate 1 acre-foot per acre on the field, the water being applied in two or three irrigations of 4 to 6 inches each. This, of course, would be the duty of water on the field, losses in transit from the source of supply not being taken into account.

IRRIGATION OF FRUIT.

No experiments have been made to determine the value of irrigation in fruit culture in the Willamette Valley, because it has been impossible to secure a tract in bearing fruit conveniently located with respect to a suitable water supply on which the use of water in irrigation might be tried. With the scarcity of rainfall, however, it seems not unreasonable to expect that even the orchard and berry patch will benefit greatly under irrigation except in cases where they are already located so as to be provided with natural subirrigation. The value of irrigation has already been demonstrated beyond question in the orchards of the Rogue River Valley, for the orchards there that are producing the heaviest and yielding the largest profits are irrigated, almost without exception. The belief that orchards in general will be benefited by intelligent irrigation seems to be well founded.

FEASIBILITY OF IRRIGATION IN WESTERN OREGON.

With the need of irrigation in western Oregon during the dry summer months conclusively proven, and with the great value of irrigation as determined by actual experiment fully demonstrated, the question arising next is the feasibility and practicability of irri-

gation development on an extended scale. Analyzing first the water supply of the region, a complete network of streams is found making its way into the valleys from both the Cascades on the east and from the Coast Range on the west. The Willamette and its tributaries, the Umpqua and its tributaries, and the Rogue River and its tributaries discharge enough water annually to cover the arable land in their respective valleys many feet in depth. It is a fact, of course, that much of this water comes at a season when it can not be made use of and that during the summer months when the greatest demand will occur the stream flow is at its lowest stage. Many of the streams, however, have a strong summer flow and this flow, where existing rights do not interfere, is available for direct diversion. Where existing rights do interfere or where the summer flow is inadequate, storage in the majority of cases can be easily and cheaply provided. There are many natural storage sites in both ranges of mountains that are capable of economical development, and already some of the more favorable ones are being developed against the time when reliance will be placed upon them to supplement the normal flow of the streams in the summer time. Fish Lake and Four Mile Lake in the Rogue River basin, for instance, are now being developed as natural storage reservoirs to be used in connection with the Rogue River Reservoir, Irrigation, and Power Company's project that is being constructed to supply the upper Rogue River Valley with irrigation water. The combined storage capacity of these two lakes is 35,000 acre-feet. Another natural lake that is being developed as a storage reservoir is Waldo Lake, on the headwaters of the Willamette River. The storage capacity of this lake when fully developed will approximate 150,000 acre-feet. Many other smaller lakes in the several drainage basins can be utilized at small expense and also many natural reservoir sites can be developed by the construction of dams, all of which can be made to supplement the normal summer flow of the streams. With such a condition existing in the matter of a water supply it can be safely said that water in abundance is available for the most extensive irrigation development.

The problem of bringing the water onto large tracts of land is comparatively a simple one in most cases, the general topography of the region being such as to eliminate long and expensive diversion canals. Especially is this the case in the Willamette Valley, where practically all of the streams emerge from the mountains on a heavy grade and where the land to be irrigated is extremely smooth, with light grades. In this valley alone many projects are capable of development where the acreage that can be controlled varies from 5,000 acres to 50,000 acres and where the actual cost of putting the water on the land will vary from $10 to $30 per acre, which is a low acreage

cost in comparison with that required in many other sections where projects have been and are now being successfully built. Speaking generally, it may be said that canal construction in the region studied will be no more expensive and involve no more difficulties than in other irrigated sections of the West; and that in particular cases, especially in the Willamette Valley, projects of 5,000 to 25,000 acres are so favorably located that the cost of their complete development will not exceed $12 or $15 per acre.

As to the ultimate effect of irrigation on the various types of soils it can be positively asserted that with the possible exception of the "white lands" of the Willamette Valley there is not a single type of soil from the extremely porous gravelly soils to the fine textured alluvial bottom lands that will not be greatly benefited by cultivation under irrigation. In the case of the "white land" irrigation will not injure it, but in its present run-down condition irrigation can be used but to slight advantage until such time as it has been brought back to a fair physical and chemical condition by intelligent crop rotation, fertilization, and underdrainage. It is the erroneous impression of a few that irrigation will sour the soil; that is, water-log it to such an extent as to prevent complete aeration and cause it to become lifeless and inert. It is contended that the soil is so thoroughly saturated by the heavy rainfall during the winter that the dry summer period is necessary to drain the soil and dry it out thoroughly before the next rainy season comes on, and that if the soil is irrigated during the dry summer it will have no opportunity to "dry out" and will "sour." Those who reach such a conclusion overlook the fact that these same soils have for hundreds of years assimilated with no ill effect a rainfall of from 30 to 40 inches each year and in doing so have developed a natural system of surface drainage and underdrainage that is entirely capable of disposing of the small amount of extra water that will be applied in irrigation. They fail also to comprehend the real purpose or method of irrigating the soil, for it is not the purpose to saturate or water-log the soil, but simply to maintain the moisture conditions necessary for good crop growth during the time when the soils would otherwise be too dry. Such a use of water on any soil can result only in benefit and no damage need be feared.

With an abundant water supply assured, with the general topography of the region such as to especially favor the cheap and economical delivery of the water on the land, and with the soils themselves adapted to irrigation, no reason is apparent why irrigation development is not feasible and practicable.

THE PART IRRIGATION WILL PLAY IN THE AGRICULTURAL DEVELOPMENT OF WESTERN OREGON.

As the result of a widespread campaign of education and advertisement, western Oregon is experiencing to-day one of the greatest eras of growth and development it has ever known. From all over the Union men are coming to this region to locate and invest their capital. Along commercial and industrial lines the development is very great indeed. Along agricultural lines there is much investment and speculation, but on the whole, little real development is taking place outside of a very few especially favored localities. This backwardness in the actual development of the agricultural industry constitutes one of the most serious economic problems confronting western Oregon. This region is essentially and preeminently an agricultural one, and the chief supporting industry will always be agriculture; yet substantial development along this line is falling far behind the development along commercial and industrial lines, and as a result an abnormal condition is rapidly being created. The cities and towns are growing rapidly, their population is increasing, but the farming industry that is to support this growth of the cities and towns is making slow progress. Outside of the favored districts that are progressing, the general farming area is clinging to the same methods and securing the same results that obtained fifteen and twenty years ago. In the heart of the large farming area, the large 320 and 640 acre farm is the rule, and the raising of grain crops that do not yield 2 per cent net return on the assessed valuation of the land is tenaciously adhered to. Land values are rising, it is true, but in the main this increase is a sympathetic and speculative one and is not based on the increased productiveness of the farm. That conditions are abnormal is proven forcibly by the fact that although it is essentially an agricultural region, the farm products of western Oregon, despite the high prices prevailing, fail absolutely to supply even the local demand. The valleys of western Oregon each year actually import from eastern States and from other outside sections, hundreds of thousands of dollars worth of ham, bacon, lard, butter, canned goods, eggs, and even hay and grain—products that should be grown in such abundance as not only to meet the local demand, but to supply an extensive export trade that waits only to be developed. With such conditions existing, it can readily be seen that normal and substantial development can not take place until such time as the agricultural industry receives an impetus that will enable it to keep pace with the development along other lines.

The reasons for this state of affairs are not difficult to locate. One of the principal reasons for the prevailing condition is that the destructive cultural methods that have been followed for half a century

have so affected the producing power of the soils that they can no longer be farmed with profit in the old manner even though earnest and consistent effort be put forth by the farmer. The soils will not respond as they once did nor can they be made to produce as they should until radical changes in methods are adopted. Another reason is that prevailing farming practice is in a rut. In the majority of cases, not only the farm lands but the farming methods have come down to the present owners as a heritage and the younger generation simply follow in the steps of the older generation which founded the industry, rather than change to the new methods that are absolutely demanded by the radical change in conditions that has taken place. They adopt improvements and innovations slowly, and cling to the methods of twenty years ago that no longer produce remunerative results. For this condition the farmers themselves are largely responsible. The most important reason of all, however, why development should be so slow is that in this necessary change from the old one-crop method to the intensified and diversified method of constructive farming, adverse climatic conditions are encountered that affect most seriously the results that should be secured under the new order of things. In the production of wheat, the dry weather in summer operated only to increase and insure the yield. Grain, however, is but a minor crop where diversified farming is practiced. Hay, fodder, root crops, vegetables, and fruit all enter into the scheme of intensive farming and these crops, growing as they do throughout the entire summer season, are at the mercy of the droughts and suffer according to their severity. Were these summer droughts of short duration or of infrequent occurrence, diversified agriculture would have had a normal development and the problem that exists would not have arisen, but they come as regularly as the seasons and the dry summers with their less than one-quarter of an inch of rainfall in sixty to seventy days in the hot summer are as much a part of the regular climatic cycle as are the heavy rains of December, January, and February. This droughty condition of each summer is the real reason why agricultural development has been so backward in western Oregon, and one of the main reasons why the old methods of years gone by have been adhered to so tenaciously. Some development is of course taking place throughout the region and certain sections that are favorably situated are being intensively developed, but agricultural practice in general is changing but slowly and but little progress is being made in the solution of the main problem.

With the summer droughts and their effects acting as the main obstacle to a normal development of the farming industry, there can be no doubt that the effect of the general adoption of irrigation will be to solve almost completely the agricultural problem that exists.

Through the application of water to crops when they are in need of moisture, methods and practices will change rapidly and farming operations will adapt themselves to the new condition without hindrance or check.

That the adoption of irrigation generally will produce these results may be most confidently expected. The cooperative experiments conducted by this Office as well as the results secured by individuals during the last three years demonstrate beyond question what can be done with irrigation. Not only can crop yields be absolutely assured, but they can be greatly increased, in some cases doubled and trebled at an expense that is trifling when compared with the increased returns secured.

Irrigation will make possible the small diversified farm of 20 to 40 acres, on which a far better living will be made than is now possible on the average farm of ten times that size. No longer will it be necessary to ship packed eggs from Kansas that sell in the local markets now for 30 and 40 cents per dozen. Eastern bacon at 25 to 27 cents per pound and eastern hams at 15 to 20 cents per pound will no longer be called upon to supply the local demand. No longer will eastern Oregon hay at $18 to $20 per ton have to be shipped to western Oregon cities and towns, nor will millstuffs at $25 and $30 per ton have to be fed by the dairyman to his herd to maintain the milk flow in the summer time. The relation of supply and demand will become adjusted, abnormal conditions will disappear, and all through the medium of the small diversified farm which is irrigated.

It will require time, of course for the adoption of irrigation to become general. It is an innovation and it is only natural that at first it should be taken up slowly, especially by those who in the past have placed their dependence upon the natural rainfall and are naturally predjudiced against any plan that "goes against Nature." But the irrigation idea will prevail and eventually the time will come when the farm that is not provided with at least a partial water supply as its insurance policy will be an exception. When that time comes, agriculture in the valleys of western Oregon will be placed upon a sound and permanent basis, and the development of the farm will assume its rightful place in the economic development of the region as a whole.

O

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION—Continued.

BULLETINS—continued.

Bul. 191. Tests of Internal Combustion Engines on Alcohol Fuel. By C. E. Lucke and S. M. Woodward. Pp. 89.
Bul. 192. Irrigation and Drainage Laws of Italy. Translated by R. P. Teele. Pp. 100.
Bul. 201. Cost of Pumping from Wells for the Irrigation of Rice in Louisiana and Arkansas. By W. B. Gregory. Pp. 39.
Bul. 203. Distribution of Water in the Soil in Furrow Irrigation. By R. H. Loughridge. Pp. 63.
Bul. 205. Irrigation in Wyoming. By Clarence T. Johnston. Pp. 60.
Bul. 207. Irrigation in the Sacramento Valley, California. By Samuel Fortier, assisted by O. W. Bryant, J. E. Roadhouse, A. E. Wright, and J. H. Barber. Pp. 99.
Bul. 209. Irrigation in Oregon. By John H. Lewis, assisted by Percy A. Cupper. Pp. 67.
Bul. 210. Irrigation in South Dakota. By Samuel H. Lea. Pp. 60.
Bul. 211. Irrigation in Kansas. By Don H. Bark. Pp. 28.
Bul. 214. Irrigation in the State of Washington. By O. L. Waller. Pp. 64.
Bul. 215. Irrigation in New Mexico. By Vernon L. Sullivan. Pp. 42.
Bul. 216. Irrigation in Idaho. By J. Stephenson, jr. Pp. 59.
Bul. 217. Drainage of Irrigated Lands in the San Joaquin Valley, California. By S. Fortier and V. M. Cone. Pp. 58.
Bul. 219. Irrigation in North Dakota. By T. R. Atkinson. Pp. 39.
Bul. 222. Irrigation in Texas. By J. C. Nagle. Pp. 92.

FARMERS' BULLETINS.

Bul. 116. Irrigation in Fruit Growing. By E. J. Wickson. Pp. 48.
Bul. 138. Irrigation in Field and Garden. By E. J. Wickson. Pp. 40.
Bul. 158. How to Build Small Irrigation Ditches. By C. T. Johnston and J. D. Stannard. Pp. 28.
Bul. 263. Practical Information for Beginners in Irrigation. By Samuel Fortier. Pp. 40.
Bul. 277. Use of Alcohol and Gasoline in Farm Engines. By C. E. Lucke and S. M. Woodward. Pp. 40.
Bul. 371. Drainage of Irrigated Lands. By C. F. Brown. Pp. 52.
Bul. 373. Irrigation of Alfalfa. By Samuel Fortier. Pp. 48.
Bul. 392. Irrigation of Sugar Beets. By F. W. Roeding. Pp. 52.
Bul. 394. The Use of Windmills in Irrigation in the Semiarid West. By P. E. Fuller. Pp. 44.

CIRCULARS.

*Circ. 48. What the Department of Agriculture is Doing for Irrigation. By Elwood Mead. Pp. 4.
*Circ. 58. Irrigation in the Valley of Lost River, Idaho. By Albert Eugene Wright. Pp. 24.
*Circ. 59. Progress Report of Cooperative Irrigation Investigations in California. By S. Fortier. Pp. 23.
*Circ. 63. Work of the Office of Experiment Stations in Irrigation and Drainage. Pp. 31.
Circ. 65. Irrigation from Upper Snake River, Idaho. By H. G. Raschbacher. Pp. 16.
Circ. 67. Investigations of Irrigation Practice in Oregon. By A. P. Stover. Pp. 30.
Circ. 78. Progress Report on Irrigation Experiments in Willamette Valley, Oregon. By A. P. Stover. Pp. 25.
Circ. 92. Progress Report on Experiments in Supplemental Irrigation with Small Water Supplies at Cheyenne and Newcastle, Wyoming, 1905–8. By O. W. Bryant. Pp. 51.
Circ. 95. Experiments in Supplemental Irrigation with Small Water Supplies at Cheyenne, Wyo., in 1909. By John H. Gordon. Pp. 11.

SEPARATES.

*Rise and Future of Irrigation in the United States. By Elwood Mead, Expert in Charge of Irrigation Investigations, Office of Experiment Stations. Pp. 591–612. (Reprint from Yearbook, 1899.)
*Some Typical Reservoirs in the Rocky Mountain States. By Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 415–430. (Reprint from Yearbook, 1901.)
*Preparing Land for Irrigation. By R. P. Teele. Pp. 239–250. (Reprint from Yearbook, 1903.)
*Potato Culture near Greeley, Colo. By J. Max Clark. Pp. 311–322. (Reprint from Yearbook, 1904.)
The Relation of Irrigation to Dry Farming. By Elwood Mead, Chief of Irrigation and Drainage Investigations, Office of Experiment Stations. Pp. 423–438. (Reprint from Yearbook, 1905.)
The Use of Small Water Supplies for Irrigation. By Samuel Fortier, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 409–424. (Reprint from Yearbook, 1907.)
*Duty of Water in the Gallatin Valley, Montana. By Samuel Fortier. Pp. II, 175–196, pls. 2, figs. 3. (Reprint from Bulletin 86 of Office of Experiment Stations.)

[Continued on fourth page of cover.]

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION—Continued.

SEPARATES—continued.

Irrigation in Utah. By R. C. Gemmell and Geo. L. Swendsen. Pp. iv, 197-218, pls. 12. (Reprint from Bulletin 86 of Office of Experiment Stations.)

Soil Mulches for Checking Evaporation. By Samuel Fortier, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 465-472, figs. 7. (Reprint from Yearbook, 1908.)

*The Scope and Purposes of the Irrigation Investigations of the Office of Experiment Stations. By Elwood Mead, Irrigation Expert in Charge. Pp. 317-327. (Reprint from Annual Report of Office of Experiment Stations for 1901.)

*Review of Irrigation Investigations for 1902. By Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 359-385. (Reprint from Annual Report of Office of Experiment Stations for 1902.)

*Review of Irrigation Investigations for 1903. By Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 469-502. (Reprint from Annual Report of Office of Experiment Stations for 1903.)

Report of Irrigation and Drainage Investigations, 1904. By Elwood Mead, Chief. Pp. 425-472. (Reprint from Annual Report of Office of Experiment Stations for 1904.)

*Losses of Irrigation Water and Their Prevention. By R. P. Teele. Pp. 369-386. (Reprint from Annual Report of Office of Experiment Stations for 1907.)

Review of Ten Years of Irrigation Investigations. By R. P. Teele. Pp. ii, 355-405. (Reprint from Annual Report of Office of Experiment Stations for 1908.)

1266

Issued September 9, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN 227.

A. C. TRUE, Director.

CALCIUM, MAGNESIUM, AND PHOSPHORUS IN FOOD AND NUTRITION.

BY

HENRY C. SHERMAN, ARTHUR J. METTLER,
AND J. EDWIN SINCLAIR,

Department of Chemistry, Columbia University.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, D. Sc., Director.
E. W. ALLEN, Ph. D., Assistant Director and Editor of Experiment Station Record.
C. F. LANGWORTHY, Ph. D., Expert in Nutrition.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., May 16, 1910.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin 227 of this Office a report of investigations on calcium, magnesium, and phosphorus in food and nutrition, carried on at Columbia University, New York City, by Henry C. Sherman, professor of organic analysis, and Arthur J. Mettler and J. Edwin Sinclair, of the department of chemistry.

The report, which supplements Professor Sherman's bulletin published by this Office on iron in food and its function in nutrition, includes a general discussion of the subject and summary of earlier literature, together with the results of six experiments on the metabolism of calcium, magnesium, and phosphorus, and a study of the amount of these mineral constituents in typical American dietaries. In general, the investigations show the importance of calcium, magnesium, and phosphorus in the diet, and the possibilities of securing these constituents by the use in proper proportion of ordinary food materials.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

CALCIUM, MAGNESIUM, AND PHOSPHORUS IN FOOD AND NUTRITION.

INTRODUCTION.

Of the elements concerned in the so-called mineral metabolism of man, at least eight—iron, calcium, magnesium, phosphorus, potassium, sodium, chlorin, and sulphur—are used in such amounts as to permit of the determination of the daily requirement by means of comparisons of intake and output.

The metabolism of iron and the iron requirements of the body have been studied and the results discussed in a previous bulletin of this series.[a] A similar investigation of each of the other elements enumerated was planned, but it has not yet been found possible to carry on the work to completion. The results which have been obtained in the preliminary study of calcium, magnesium, and phosphorus are given in this bulletin as a progress report.

OCCURRENCE AND METABOLISM OF CALCIUM AND MAGNESIUM.

There seem to be three main ways in which the so-called ash constituents may exist in the body and take part in its functions: (1) As part of the permanent structures, such as the bones; (2) as essential elements of the living substances of the active tissues; and (3) as salts held in solution in the fluids of the body and helping to give these fluids their characteristic physico-chemical properties and influence upon the elasticity and irritability of muscles and nerves. Calcium is the most abundant metallic element in the body and plays an important part in each of these three directions. Its phosphate is the chief mineral constituent of all of the bones, its combinations with proteid are essential to the highly nucleated cells which are most active in the nutritional functions, and its soluble salts have a great influence upon the properties of the body fluids and their effects upon the muscles. Magnesium is probably as widely distributed in the body as calcium, but the amount is much less, the

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 185.

usual estimate allowing about 20 parts lime to 1 part magnesia for the body as a whole.

In general, the magnesium salts are more readily soluble in the body fluids and are not so largely deposited in the bones as are the lime salts. Thus Heiss found that of the total amounts present in the body of a dog, 99.5 per cent of the calcium and only 71 per cent of the magnesium belonged to the bones. The muscles contain more magnesia than lime, but the blood is richer in lime than in magnesia.

Of the total lime taken in the food, usually much the smaller part is excreted through the kidneys. The large proportion of ingested lime which passes out through the intestine has often been interpreted as indicating that the absorption of lime from food is poor and the calcium requirement of the body low. This inference, however, is not justified, for in the case of calcium, as also of iron, the normal path of elimination of the material broken down in the body is not through the kidneys, but through the walls of the intestines. The elimination of lime through the intestine continues even when no food is taken.

E. Voit[a] long ago demonstrated directly the elimination of lime compounds through the intestinal wall, but evidently underestimated the amount. According to Forster's[b] experiments, 60 per cent of the lime taken was absorbed, while only a very small portion was excreted in the urine.

The amounts of lime ordinarily excreted per day in the urine vary with the food and are given by different authors as between 0.15 and 0.5 gram.

Both the organic and the inorganic calcium compounds of the food are available to the body. While the absorption of insoluble lime salts is sometimes questioned, it has, according to Lusk,[c] been conclusively shown that such salts when eaten produce an increase in the calcium of the urine, and that, according to Rüdel,[d] blood has a special capability for carrying calcium phosphate. Lusk states that if calcium chlorid be given a little of the calcium appears in the urine and all of the chlorin. In diabetes, where a large production of acids tends to neutralize the blood, the more acid urine contains an increased amount of calcium.

According to Lusk,[c] considerations regarding the absorption of calcium apply also to magnesium. It is absorbed from the intestine in both organic and inorganic forms. If growing rabbits be fed on a

[a] Ztschr. Biol., 16 (1880), p. 55.
[b] Arch. Hyg., 2 (1884), p. 385.
[c] American Text-Book of Physiology. Philadelphia, 1900, p. 971.
[d] Arch. Expt. Path. u. Pharmakol., 33 (1893), p. 90.

diet poor in calcium but containing magnesium carbonate, the bones may be brought to contain double the normal quantity of magnesium, but the skeletal development remains far behind that of a normal rabbit, so that, as Weiske[a] points out, magnesium can not be considered a substitute for calcium. The magnesium salts, being more soluble than the calcium salts, occur in the urine in greater abundance. Indeed, in carnivorous animals the major part of excreted magnesium is found in the urine, the balance being given off through the intestinal wall to the feces.

It is of course especially important that the calcium and magnesium salts should be normally absorbed during the periods of infancy and childhood, when the skeleton is growing rapidly. The absence of a sufficient quantity of fat in the food (and it is thought also the presence of a greatly excessive amount) tends to deprive the growing body of its normal supply of calcium and magnesium salts, and is one of the factors in the production of nutritional disorders. The recent literature on disturbances of the calcium metabolism is far too extensive to be touched upon here.

FEEDING AND FASTING EXPERIMENTS WITH REFERENCE TO CALCIUM AND MAGNESIUM.

Several experiments have been made to show the effect of food poor in lime upon the growth and health of animals and to determine the extent to which calcium can be replaced by other alkali earths.

Weiske has given especial attention to this subject, working largely upon rabbits and using oats as the food poor in lime. The harmful effects of an exclusive oat diet have been attributed to the acidity of the products of metabolism and can be prevented at least in large measure by the addition of calcium carbonate to the food. With adults the use of magnesium carbonate seems to be equally effective. In his first experiments to determine the nutritive value of lime salts, Weiske[b] selected the sulphate and phosphate—sparingly soluble salts of rather strong acids. Five rabbits were selected for the experiment; two were killed and analyzed as controls, two fed for 47 days with oats plus calcium sulphate, and one with the same food plus calcium phosphate. Under this feeding there was no increase in weight, either of the body or of the dry, fat-free bones. The amount of mineral matter in the bones apparently decreased somewhat but not to a marked extent.

Here the sulphate and phosphate of lime evidently were not utilized by the skeleton, which was, on the other hand, apparently attacked to a slight extent by the acid products of metabolism of the

[a] Ztschr. Biol., 31 (1894), p. 437.

[b] Ztschr. Physiol. Chem., 20 (1895), p. 595; Jahresber. Tier-Chem., 25 (1895), p. 526.

food. Weiske believed that a more pronounced loss of mineral matter would have been shown had the feeding been continued for a longer period.

In another series of experiments Weiske found that no strontium was contained in the bones of a rabbit which had received strontium phosphate in addition to a normal diet, and that addition of calcium or magnesium phosphate to a normal diet did not increase the calcium or magnesium content of the bones above the normal.

A third experiment was made with rabbits fed on oats, a feed poor in lime but rich in the other necessary nutrients. The lime content of oats is great enough for the needs of grown animals but not for young, growing animals. Five rabbits were used. To the feed of the first no salts were added, to that of the second calcium carbonate was added daily, to that of the third calcium sulphate, to that of the fourth strontium carbonate, and to that of the fifth magnesium carbonate. The weight of the rabbits changed differently in each case. The rabbit fed without the addition of salts lost weight to a large extent. The one fed with calcium sulphate lost still more weight, and after one and a half months died after growing very lean. The animal fed with calcium carbonate gained the most weight, and the one fed with magnesium carbonate gained the next most weight. During the first month the animal fed with strontium carbonate gained as much as the one fed on magnesium carbonate; but in the last three weeks the animal lost weight. At the end of the experiment the animals were killed and the amounts of calcium, strontium, magnesium, and phosphorus were determined in the blood, the flesh, and the liver. The flesh of the rabbit fed with magnesium carbonate contained more magnesia than that of the other animals. The flesh, blood, and liver of the animal fed on strontium carbonate contained a small amount of strontia and more phosphoric acid than those of any of the other animals. Weiske concluded that with herbivora, not yet full grown and fed on a so-called acid food poor in lime, the addition of the carbonates of the alkali earths to the food so acts as to decrease or abolish the acid condition of the feed which is harmful for herbivora. The calcium carbonate gave the best results. This is evidently due to the fact that the deficiency of lime in the oats could not be compensated by magnesia or strontia, magnesium and strontium being unable to take the place of calcium in the animal economy.

The results of a lack of lime are better shown by feeding experiments of long duration in which the subject receives a sufficient amount of total food but only a small amount of calcium in any form. Under such conditions the active tissues appear to have the power of making good their losses at the expense of those parts which can be weakened with least immediate injury to the body as a whole.

Voit[a] in an experiment in which pigeons were fed with a diet poor in lime for a long time noticed no effect until the birds were killed and dissected, when it was found that although the bones concerned in locomotion were still sound, the skull and sternum were very weak and thin and in places perforated. Under similar conditions in mammals, the teeth would probably be injured also.

Weakening of the bones through lack of sufficient lime in the food is of course much more apparent during growth than in the adult. Abnormal weakness and flexibility of the bones, corresponding with rickets as observed in children, can be brought about experimentally in puppies by feeding them with meat and fat alone, while those receiving the same food with addition of bones grow normally, according to data cited by Lusk.[b]

Evidently it is not safe to assume that food furnishing sufficient protein and fuel value will necessarily furnish sufficient lime. Neither can the amount of lime excreted in the urine be taken as an indication of the lime requirements of the body. This can be ascertained only by means of metabolism experiments in which the balance of intake and output is determined.

EXPERIMENTS UPON THE INCOME AND OUTGO OF CALCIUM AND MAGNESIUM.

The purpose of this section is to bring together the results of metabolism experiments which throw light upon the calcium and magnesium requirements of healthy men, with only such data regarding diseased subjects and lower animals as appear to bear directly upon these requirements.

The earliest available work which now appears to be of value is that of Bertram,[c] who made experiments in three periods of three days each on a mixed diet of meat, fat, beer, coffee, and sodium chlorid. In period 2 he consumed in addition 40 grams of potassium citrate and in period 3, used 10 grams of calcium carbonate. His results are shown in the following table:

Daily income and outgo of lime and magnesia. Bertram's experiments.

Period.	Calcium oxid.				Magnesium oxid.			
	In food.	In urine.	In feces.	Gain (+) or loss (−).	In food.	In urine.	In feces.	Gain.
	Grams.	*Gram.*	*Grams.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
First	0.385	0.167	0.233	−0.015	0.730	0.268	0.428	0.034
Second	.385	.095	.292	− .002	.730	.269	.443	.018
Third	5.985	.298	5.414	+ .273	.730	.330	.398	.002

[a] Hermann's Handbuch der Physiologie. Leipsic, 1881, vol. 6, p. 379.
[b] American Text-Book of Physiology. Philadelphia, 1900, p. 969.
[c] Ztschr. Biol., 14 (1878), p. 354.

Gramatchikov [a] in 1890 studied five fever patients, determining in each case the income and outgo of lime and magnesia (as well as other inorganic elements) both during fever and during a period of convalescence when fever was absent. The food consisted of bread and milk, in some cases with the addition of meat, except in two cases, in which meat but no milk was taken. The figures obtained for lime are given in the tables immediately following:

Daily income and outgo of lime (CaO). Gramatchikov's experiments.

Subject.	Period.	Body weight.	Calcium oxid. In food.	In urine.	In feces.	Gain (+) or loss (−).
		Kilograms.	*Grams.*	*Gram.*	*Grams.*	*Grams.*
No. 1	Fever	55.5	2.5	0.7	1.9	−0.1
No. 1	....do	53.6	2.8	.4	2.5	− .1
No. 1	No fever	57.6	3.9	.4	1.8	+1.7
No. 2	Fever	58.9	3.1	.1	2.7	+ .3
No. 2	No fever	67.5	2.2	.3	1.2	+ .7
No. 3	Fever	44.0	3.6	.5	2.9	+ .2
No. 3	No fever	45.8	.4	.2	.2	.0
No. 4	Fever	53.0	4.1	.4	3.6	+ .1
No. 4	No fever	50.5	2.2	.4	1.7	+ .1
No. 5	Fever	41.0	3.1	.4	2.7	.0
No. 5	No fever	42.3	.5	.2	.2	+ .1

Daily income and outgo of magnesium oxid (MgO). Gramatchikov's experiments.

Subject.	Period.	Body weight.	Magnesium oxid. In food.	In urine.	In feces.	Gain (+) or loss (−).
		Kilograms.	*Grams.*	*Gram.*	*Gram.*	*Gram.*
No. 1	Fever	55.5	0.7	0.3	0.2	+0.2
No. 1	....do	53.6	.8	.3	.5	.0
No. 1	No fever	57.6	1.3	.5	.3	+ .5
No. 2	Fever	58.9	.7	.2	.4	+ .1
No. 2	No fever	57.5	.8	.3	.3	+ .2
No. 3	Fever	44.0	.6	.3	.3	.0
No. 3	No fever	45.8	.5	.2	.2	+ .1
No. 4	Fever	53.0	.7	.1	.6	.0
No. 4	No fever	50.5	.9	.3	.5	+ .1
No. 5	Fever	41.0	.6	.3	.4	− .1
No. 5	No fever	42.3	.6	.2	.4	.0

Gramatchikov concluded that fever has little effect upon the metabolism of calcium and magnesium. If this is true the figures for these experiments should be fairly comparable with those made upon healthy subjects which follow.

The influence of adding large amounts of calcium carbonate to the food has been studied by Herxheimer [b] in metabolism experiments

[a] Inaug. Diss., St. Petersburg; abs. in U. S. Dept. Agr., Office Expt. Stas. Bul. 45, pp. 189, 194.

[b] Berlin. Klin. Wchnschr., 34 (1897), p. 423; abs. in Jahresber. Tier-Chem., 27 (1897), p. 698.

which, although arranged principally with reference to the therapeutic aspects of the practice, are interesting in showing the possibility of a large storage of calcium.

Calcium carbonate having been recommended in place of alkali carbonate for the treatment of uric acid concretions of the kidneys and used in the shape of "lime bread," the action of this bread was studied by Herxheimer in an eleven-day experiment. After three normal days an average of 300 grams of bread containing 18 grams calcium carbonate were given per day on the next five days, and for the next three days an average of 300 grams of "2 per cent bread" containing 6 grams of calcium carbonate were given. The results were as follows:

The volume of urine, the nitrogen balance, and the excretion of uric acid were not influenced by the supply of lime to any noticeable degree. Most of the lime excreted was given out in the feces and only a small part in the urine. Not less than 15.9 grams of the supplied lime remained, however, in the body. The total phosphoric acid excreted remained practically the same during the whole experiment; the phosphate in the urine decreased, while that in the feces increased correspondingly. The monosodium phosphate in the urine decreased, while the disodium phosphate increased. The acidity of the urine proportionally decreased and attained a weakly acid or amphoteric state.

Gottstein[a] determined the income and outgo of calcium and magnesium in metabolism experiments in which casein and edestin were fed either with or without the addition of mixtures of salts. As the experiments all gave a negative balance for calcium and magnesium, the influence of the different proteid bodies on the matabolism of the alkali earths could not be positively determined. The excretion of magnesium increased with that of nitrogen. In nitrogen storage the magnesium loss was less. In these experiments calcium showed no such relation. Phosphorus and magnesium balances changed in like manner, but no relation of calcium to phosphorus could be discovered. The reported parallelism of the phosphorus and magnesium balances in this experiment is interesting, as Loew has found that the metabolism of these two elements in plants is closely connected, magnesium apparently serving as a phosphate carrier in vegetable metabolism.

Renvall's[b] investigations were made primarily to determine the need of adult man for phosphorus, calcium, and magnesium. The subject (Renvall) was 22 years old, 174 centimeters high, and weighed 71.1 kilograms. He was of a nervous temperament and

---

[a] Inaug. Diss., Breslau, 1901; abs. in Jahresber. Tier-Chem., 31 (1901), p. 636.

[b] Skand. Arch. Physiol., 16 (1904), p. 94.

worked about 15 hours daily in the laboratory, sleeping 7 hours. Renvall says of his physical condition, "sehr reichlichte Salzsäureabsonderung im Ventrikel sonst völlig gesund."

The experiment lasted 32 days, and the diet consisted of dry bread, smoked ham, cheese, butter, oatmeal, zwieback, sodium chlorid, and in the last 17 days of the experiment, chalk.

The experiment was divided into five periods of 8, 7, 6, 5, and 5 days, respectively. Nothing was eaten for 18 hours before and after the experiment, and the separation of the feces was accomplished by eating dried blueberries for markers.

Calcium and magnesium were determined in the urine by precipitating with ammonium hydroxid, filtering and dissolving the precipitate in dilute hydrochloric acid, and then adding ammonium acetate and a few drops of glacial acetic acid. Ammonium oxalate in solution was then added to the hot solution to precipitate the calcium. After standing 6 hours the calcium oxalate was filtered off and ignited and weighed as CaO. In the filtrate the magnesium was precipitated with ammonium hydroxid, filtered, ignited, and weighed as $Mg_2P_2O_7$. For each determination 200 cubic centimeters of urine were taken.

Calcium and magnesium in the feces were found by ashing, dissolving the ash in hydrochloric acid, and precipitating the phosphorus with ammonium acetate and ferric chlorid, and reprecipitating twice. In the filtrate, after boiling to small bulk, the lime was precipitated as oxalate, and in this filtrate the magnesium was precipitated as magnesium ammonium phosphate with ammonium hydroxid and sodium phosphate.

The nitrogen balance was as follows:

Daily income and outgo of nitrogen. Renvall's experiments.

Period.	Nitrogen.			
	In food.	In urine.	In feces.	Gain (+) or loss (−).
	Grams.	*Grams.*	*Grams.*	*Grams.*
First	12.10	15.29	2.15	−5.34
Second	13.70	14.02	2.34	−2.66
Third	16.10	16.28	2.56	−2.74
Fourth	22.73	19.64	2.95	+.14
Fifth	21.22	20.10	3.59	−2.47

The calcium balance is given below:

Daily income and outgo of calcium (Ca). Renvall's experiments.

Period.	Calcium.			
	In food.	In urine.	In feces.	Gain (+) or loss (−).
	Grams.	*Gram.*	*Grams.*	*Gram.*
First	0.860	0.507	0.325	+0.028
Second	.909	.505	.331	− .017
Third	1.197	.557	.476	+ .164
Fourth	1.486	.649	.664	+ .173
Fifth	1.470	.609	.850	+ .011
Eight days following first period	....	.505	1.230	....
Six days following second period	....	.374	.681	....
Eight days following third period	....	.401	1.178	....

The chief peculiarity here is the large amount of calcium in the urine. In the first three periods the amount of lime in the urine is greater than that in the feces, while in other experiments (Bertram, Herxheimer, etc.) the opposite is the rule. In the first period there was almost a calcium equilibrium. From the increased storage of lime in the third and fourth periods, in which calcium carbonate was added to the food, it is seen that the body absorbed lime from the calcium carbonate given. In the last period, however, there apparently occurred no absorption of lime from the calcium carbonate. The results obtained indicate that the body tends toward a calcium equilibrium, which would account for the rapid falling off in the storage of lime in the fifth period.

From the first period it is seen that the body can maintain calcium equilibrium with less than 0.860 gram Ca per day. In Bertram's experiment the subject apparently showed calcium equilibrium with about 0.400 gram CaO.

The magnesium balance is given below:

Daily income and outgo of magnesium (Mg). Renvall's experiments.

Period.	Magnesium.			
	In food.	In urine.	In feces.	Gain (+) or loss (−).
	Gram.	*Gram.*	*Gram.*	*Gram.*
First	0.412	0.139	0.286	−0.013
Second	.499	.132	.326	+ .041
Third	.559	.143	.337	+ .079
Fourth	.621	.170	.327	+ .124
Fifth	.625	.171	.398	+ .056
Eight days following first period	....	.142	.242	....
Six days following second period	....	.147	.258	....
Eight days following third period	....	.149	.263	....

Renvall also studied the source of nitrogen, phosphorus, calcium, and magnesium eliminated by the intestine. It is known that the feces contain substances which are not the residue of the food eaten, but are products of the body, either excretory products or residues of the digestive juices not absorbed. The excretory products can be best studied in feces from fasting subjects. The feces in starvation, however, can not be compared to normal feces, as the latter contain not only the excretion products contained in the former, but also substances given off in the process of digestion, and it is probable that these are in larger quantities as the food eaten increases. It is as yet impossible to differentiate between the above products, but an idea as to the amount of these different substances can be obtained by examining the feces from a diet very poor in the element or substance under investigation. Renvall made experiments in this way on himself and two friends. He used a diet poor in nitrogen, phosphorus, calcium, and magnesium (sago, water, and sugar), and the feces were separated by using blueberries as a marker after 18 hours' fasting. The calcium balance is given below, while the magnesium balance is given in the table immediately following it:

Daily income and outgo of calcium (Ca). Renvall's experiments.

Subject.	Duration of test.	Calcium oxid.			
		In food.	In urine.	In feces.	Loss.
		Gram.	*Gram.*	*Gram.*	*Gram.*
Renvall	First day	0.101	0.176	0.165	0.240
Do	Second day	.079	.118	.165	.204
Subject No. 1	First day	.116	.044	.163	.091
Do	Second day	.126	.045	.163	.082
Subject No. 2	First day	.070	.060	....	....
Do	Second day	.061	.044	....	....

Daily income and outgo of magnesium (Mg). Renvall's experiments.

Subject.	Duration of test.	Magnesium.			
		In food.	In urine.	In feces.	Loss.
		Gram.	*Gram.*	*Gram.*	*Gram.*
Renvall	First day	0.026	0.074	0.067	0.115
Renvall	Second day	.021	.065	.067	.1[illegible]1
Subject No. 1	First day	.030	....	.064	....
Subject No. 1	Second day	.032	.029	.064	.061
Subject No. 2	First day	.019	.045	....	....
Subject No. 2	Second day	.016	.038	....	....

Von Wendt,[a] following methods somewhat similar to those of Renvall, with whose work he appears to have been intimately acquainted, has determined the income and outgo of calcium and magnesium (as well as of nitrogen, iron, phosphorus, sulphur, and chlorin) in an extended series of experiments, partly with food poor both in ash constituents and in protein, partly with a diet containing ample protein but insufficient ash constituents. In many cases, also, known amounts of pure salts were taken with the food; and finally the series was concluded with a metabolism experiment in which the subject took the kinds and amounts of food to which he had been accustomed in ordinary life. A diet of the first description consisting of sago, sugar, and butter was taken during experiments Nos. 1, 2, 3, and 4; one of the second sort consisting of bread, butter, sugar, and coagulated white of egg was taken in experiment No. 5, periods A and B; and one of the third sort consisting of bread, butter, meat, cheese, tea, and sugar, was taken in experiment No. 6.

The separation of the feces was accomplished by giving 2 grams of carbon (lampblack) at the first or last mealtime of each experiment.

From the diet of sago, butter, and sugar Von Wendt obtained 0.10–0.15 gram phosphorus, about 0.04 gram calcium, and 0.015 gram magnesium. The feces from this diet contained the smallest amounts of phosphorus, calcium, and magnesium yet noted in any except fasting experiments, viz, 0.099 gram phosphorus, 0.156 gram calcium, and 0.015 gram magnesium. The feces, therefore, contained practically the same amount of phosphorus and magnesium, and four times as much calcium as was taken in the food. Here at least 0.106 gram of calcium from the body was excreted through the intestine, and this, if excreted in the form of phosphate, would account for all the phosphorus which the feces contained. The amount of magnesium is only a trifle larger than was found by Müller in the fasting feces of Cetti and Breithaupt, indicating that the digestion and absorption of enough carbohydrates and fats to yield 1,500 to 3,000 calories per day does not appreciably increase the intestinal elimination of magnesium.

According to Von Wendt, the capacity of the urine for dissolving calcium salts does not regulate the amount excreted by the urine. In the acid urine the calcium is in a soluble form, while in the alkaline feces the calcium is present mostly in insoluble forms, probably as tricalcium phosphate. Calcium is transferred from the blood into the intestines probably as dicalcium and monocalcium phosphate. As only the monocalcium phosphate is soluble in the weakly alkaline intestinal secretions, Von Wendt believes that calcium is probably mostly absorbed in this form. He calls attention to the fact that the

---

[a] Skand. Arch. Physiol., 17 (1905), p. 211.

proportion of calcium absorbed to phosphorus absorbed is about the same as that of calcium to phosphorus in monocalcium phosphate, the slight difference being accounted for by the fact that dicalcium phosphate is also slightly soluble in the intestinal juices. This reasoning is, however, open to the objection that there is as yet no accurate measure of the calcium absorbed, the unabsorbed calcium and that which has been used in the body and excreted through the intestinal wall appearing together in the feces.

Von Wendt found that the consumption of common salt increases the renal and decreases the intestinal elimination of calcium. In experiment No. 6 on ordinary mixed diet practically uniform, both qualitatively and quantitatively, two subjects gave the following results:

With Subject G the daily excretion of calcium in the urine was 0.22 gram and in the feces 0.85 gram, making a total of 1.07 grams.

With Subject L the quantity excreted in the urine was 0.09 gram and in the feces 1 gram, making a total of 1.09 grams.

This difference was found by further trials to be due to the fact that Subject G took more salt on his food than Subject L, and Von Wendt states that the greater the amount of sodium chlorid consumed the greater the renal elimination and the smaller the intestinal elimination of calcium.

Von Wendt discusses at length the probable forms of phosphate eliminated in the feces and in the urine, and seems to believe that the relative abundance of phosphorus and of bases will govern the proportions of acid, neutral, and tribasic phosphates, and thus determine the proportion of phosphorus eliminated through the intestine.

Results of Von Wendt's experiments follow in tabular form.

Income and outgo of calcium oxid (CaO). Von Wendt's experiments.

Experiment.	Food and supplements.	Calcium oxid.			
		In food.	In urine.	In feces.	Gain (+) or loss (−).
Experiment No. 1:		*Grams.*	*Gram.*	*Grams.*	*Gram.*
First day	Sago, sugar, and butter	0.035	0.040	0.156	−0.161
Second day	....do	.050	.020	.156	− .126
Third day	Sago, sugar, and butter, with 0.1 gram Fe as carbonate.	.044	.100	(.156)	(− .122)
Fourth day	Sago, sugar, and butter, with 2 grams $CaSO_4$ and 0.09 gram Fe.	.053	....	(.156)	....
Experiment No. 2:					
First day	Sago, sugar, and butter	.024	.036	.240	− .252
Second day	....do	.037	.020	.240	− .223
Third day	Sago, sugar, and butter, with 4 grams NaCl.	.035	.022	.240	− .227
Experiment No. 3:					
First day	Sago, sugar, and butter, with 5 grams NaCl and 3 grams $CaHPO_4$.	.920	.059	.479	+ .382
Second day	Sago, sugar, and butter, with 8 grams NaCl and 3 grams $CaHPO_4$.	.920	.081	.510	+ .329
Third day	Sago, sugar, and butter, with 12 grams NaCl and 3 grams $CaHPO_4$.	.922	.066	.549	+ .307
Experiment No. 4:					
First day	Sago, sugar, and butter, with 5 grams NaCl and 3 grams $CaHPO_4$.	.916	.127	.413	+ .376
Second day	....do	.917	.114	.413	+ .390
Experiment No. 5:					
Period A—					
First day	Bread, butter, sugar, and egg white	.283	.111	.310	− .138
Second day	....do	.273	.115	.805	− .647
Third day	....do	.266	.100	.962	− .796
Fourth day	Bread, butter, sugar, and egg white, with 3 grams $CaHPO_4$.	1.145	.133	.400	+ .612
Fifth day	Bread, butter, sugar, and egg white	.262	.154	.400	− .292
Sixth day	Bread, butter, sugar, and egg white, with 10 grams NaCl.	.261	.137	.256	− .132
Seventh day	Bread, butter, sugar, and egg white, with 20 grams NaCl.	.262	.206	.256	− .200
Period B—					
First day	Bread, butter, sugar, and egg white	.161	.151	.256	− .246
Second day	Bread, butter, sugar, and egg white, with 3 grams ammonium citrate.	.171	.131	.242	− .202
Third day	Bread, butter, sugar, and egg white, with 0.038 gram Fe (sulph. ferr.).	.173	.104	.254	− .185
Fourth day	Bread, butter, sugar, and egg white, with 1 gram K_2CO_3.	.157	.083	.254	− .180
Fifth day	Bread, butter, sugar, and egg white, with 2.25 grams ammonium citrate and 2.25 grams $CaHPO_4$.	.820	.079	.640	+ .101
Sixth day	Bread, butter, sugar, and egg white, with 3 grams ammonium citrate and 3 grams $CaHPO_4$.	1.049	.078	.894	+ .077
Seventh day	Bread, butter, sugar, and egg white	.070	.078	.340	− .348
Period C—					
First day	Bread, butter, sugar, and meat, with 3 grams NaCl.	.223	.124	.310	− .211
Second day	Bread, butter, sugar, and meat	.177	.209	.310	− .342
Experiment No. 6:					
Period G—					
First day	Bread, butter, meat, cheese, tea, and sugar, with 2 grams NaCl.	1.063	.165	1.001	− .103
Second day	Bread, butter, meat, cheese, tea, and sugar, with 8 grams NaCl.	1.230	.226	1.001	+ .003
Third day	Bread, butter, meat, cheese, tea, and sugar, with 15 grams NaCl.	1.230	.277	1.001	− .048
Fourth day	Bread, butter, meat, cheese, tea, and sugar, with 15.5 grams NaCl.	1.230	.318	1.824	− .912
Period L—					
First day	Bread, butter, meat, cheese, tea, and sugar, with 2 grams NaCl.	1.063	.132	1.005	− .074
Second day	Bread, butter, meat, cheese, tea, and sugar, with 8 grams NaCl.	1.230	.173	1.005	+ .052
Third day	Bread, butter, meat, cheese, tea and sugar.	1.230	.189	1.005	+ .036

Income and outgo of magnesium oxid (MgO). Von Wendt's experiments.

Experiment.	Food and supplements.	Magnesium oxid.			
		In food.	In urine.	In feces.	Gain (+) or loss (−).
Experiment No. 1:		*Gram.*	*Gram.*	*Gram.*	*Gram.*
First day	Sago, sugar, and butter	0.011	0.044	0.015	−0.048
Second day	....do	.016	.033	.015	− .032
Third day	Sago, sugar, and butter, with 0.1 gram Fe as carbonate.	.014	.030	(.015)	(− .031)
Fourth day	Sago, sugar, and butter, with 2 grams $CaSO_4$ and 0.09 gram Fe.	.017	.026	(.015)	(− .024)
Experiment No. 2:					
First day	Sago, sugar, and butter	.008	.020	.040	− .052
Second day	....do	.012	.028	.040	− .056
Third day	Sago, sugar, and butter, with 4 grams NaCl	.012	.029	.040	− .057
Experiment No. 3:					
First day	Sago, sugar, and butter, with 5 grams NaCl and 3 grams $CaHPO_4$.	.012	.036	.019	− .043
Second day	Sago, sugar, and butter, with 8 grams NaCl and 3 grams $CaHPO_4$.	.014	.032	.020	− .038
Third day	Sago, sugar, and butter, with 12 grams NaCl and 3 grams $CaHPO_4$.	.013	.069	.022	− .078
Experiment No. 4:					
First day	Sago, sugar, and butter, with 5 grams NaCl and 3 grams $CaHPO_4$.	.012	.049	.028	− .065
Second day	....do	.011	.045	.028	− .062
Experiment No. 5:					
Period A—					
First day	Bread, butter, sugar, and egg white	.224	.058	.174	− .008
Second day	....do	.212	.068	.137	+ .007
Third day	....do	.204	.086	.098	+ .020
Fourth day	Bread, butter, sugar, and egg white, with 3 grams $CaHPO_4$.	.205	.103	.092	+ .010
Fifth day	Bread, butter, sugar, and egg white	.202	.086	.092	+ .024
Sixth day	Bread, butter, sugar, and egg white, with 10 grams NaCl.	.201	.092	.099	+ .010
Seventh day	Bread, butter, sugar, and egg white, with 20 grams NaCl.	.202	.110	.099	− .007
Period B—					
First day	Bread, butter, sugar, and egg white	.078	.084	.099	− .105
Second day	Bread, butter, sugar, and egg white, with 3 grams ammonium citrate.	.078	.076	.078	− .076
Third day	Bread, butter, sugar, and egg white, with 0.038 gram Fe (sulph. ferr.).	.079	.061	.050	− .032
Fourth day	Bread, butter, sugar, and egg white, with 1 gram K_2CO_3.	.070	.057	.076	− .063
Fifth day	Bread, butter, sugar, and egg white, with 2.25 grams ammonium citrate and 2.25 grams $CaHPO_4$.	.073	.049	.060	− .036
Sixth day	Bread, butter, sugar, and egg white, with 3 grams ammonium citrate and 3 grams $CaHPO_4$.	.078	.031	.040	+ .007
Seventh day	Bread, butter, sugar, and egg white	.018	.034	.030	− .046
Period C—					
First day	Bread, butter, sugar, and meat, with 3 grams NaCl.	.260	.021	.213	+ .026
Second day	Bread, butter, sugar, and meat	.211	.028	.213	− .030
Experiment No. 6:					
Period G—					
First day	Bread, butter, meat, cheese, tea, and sugar, with 2 grams NaCl.	.320	.085	.242	− .007
Second day	Bread, butter, meat, cheese, tea, and sugar, with 8 grams NaCl.	.327	.125	.242	− .040
Third day	Bread, butter, meat, cheese, tea, and sugar, with 15 grams NaCl.	.327	.129	.242	− .044
Fourth day	Bread, butter, meat, cheese, tea, and sugar, with 15.5 grams NaCl.	.327	.123	.192	+ .012
Period L—					
First day	Bread, butter, meat, cheese, tea, and sugar, with 2 grams NaCl.	.320	.103	.234	− .017
Second day	Bread, butter, meat, cheese, tea, and sugar, with 8 grams NaCl.	.327	.119	.234	− .026
Third day	Bread, butter, meat, cheese, tea, and sugar	.327	.122	.234	− .029

OCCURRENCE AND METABOLISM OF PHOSPHORUS.

Phosphorus, like calcium, is an important constituent of the bones, of the active tissues, and also of the body fluids. Calcium phosphate is the chief mineral ingredient of bone and is supposed to constitute about three-fourths of the entire ash of the body. Phosphorus compounds are also the most prominent as constituents of the muscles and blood corpuscles and stand next to the chlorids in abundance in the plasma and lymph. Voit estimated that a human body weighing 70 kilograms (154 pounds) would contain: In the bones, 1,400 grams phosphorus; in the muscles, 130 grams; in the brain and nerves, 12 grams.

As the phosphorus of the tissues exists largely in the form of nucleo-proteids and nucleins—the characteristic substances of cell nuclei—and as these cell constituents are most active in metabolism, whereas the material of the bones is commonly assumed to be comparatively inactive, there has been a tendency to regard the phosphorus metabolism as in some degree a measure of the nucleo-proteid metabolism, as the output of nitrogen is taken as a measure of the metabolism of protein in general.

Several investigators[a] have studied the urinary excretion of phosphates as influenced by those conditions which are believed to be connected with the metabolism of nucleins, and an intimate connection between changes in the phosphorus eliminated and in the katabolism of nucleins is evidently assumed by Dunlop, Paton, Stockmann, and Maccadam[b] in interpreting the results of their investigations of the effect of muscular exertion. In these experiments each subject was kept on a uniform diet for 7 days, on the fourth of which as much exercise (bicycle riding) was taken as could be endured without serious discomfort. In each case the day or days following the exertion showed an increased elimination of nitrogen and sulphur, but only when the subject was in poor training was there a corresponding increase in the elimination of phosphates and of uric acid. From this it was concluded that with the subject in good training only simple proteid is broken down, while if the subject be in poor training this consumption of simple proteid is accompanied by a consumption of nucleo-proteid. In this connection it is interesting to note the observation previously made by Preysz,[c]

---

[a] Moraczewski. Arch. Path. Anat. u. Physiol. [Virchow], 151 (1898), p. 22; Milroy and Malcom. Jour. Physiol., 23 (1898), p. 217, and 25 (1899), p. 105; White and Hopkins, Ibid., 24 (1899), p. 42; Loewi. Arch. Expt. Path. u. Pharmakol., 44 (1900–1), p. 1; abs. in Jour. Chem. Soc. [London], 78 (1900), II, p. 417.

[b] Jour. Physiol., 22 (1897–98), p. 68.

[c] Ungar. Arch. Med., 1 (1892–93), p. 38; rev. in Arch. Physiol. [Pflüger], 54 (1893), p. 21.

that the increased elimination of phosphoric acid resulting from walking a given distance (25 kilometers) was considerably greater when the distance was walked at a rapid rate, causing a more intense though less prolonged exertion.

On the other hand, it was early shown by Voit that the body material katabolized during fasting comes quite largely from the bones; and Jordan, Hart, and Patten,[a] as the result of an extended investigation of the phosphorus compounds of feeding stuffs and their behavior when fed to herbivorous animals, have concluded that the phosphorus metabolism consists largely in the formation of inorganic phosphates from comparatively simple organic compounds such as phytin.

Whether the phosphorus elimination can in any case be taken as an indication of nucleo-proteid metabolism or not, it is certain that the output of phosphorus and the output of nitrogen do not run parallel and can not, therefore, be measures of the same set of metabolic changes.

In a set of experiments by Sherman and Hawk,[b] carried out primarily for the purpose of studying the time relations of the elimination of nitrogen, sulphur, and phosphorus after ingestion of meat, the course of renal elimination of these three elements was observed simultaneously, the urine being collected in 3-hour periods during the day with a 9-hour period at night. The rates of elimination for nitrogen and sulphur were found to run nearly parallel, rising and falling twice during the day and reaching a minimum during the night. The fluctuations, though quite regular, were not very great, the highest rate of elimination found for any 3-hour period during the day being usually only about one-fourth greater than the average rate for the 9 hours of the night. On the other hand, in the elimination of phosphorus the fluctuations, though less regular, were considerably larger, the maximum rate of elimination being two or three times the minimum. The minimum rate of elimination of phosphorus, unlike that of nitrogen and sulphur, was reached not during the night but at some time in the forenoon, usually from 1 to 3 hours, but sometimes from 4 to 6 hours, after rising. Moreover, these experiments taken in connection with those of Rosemann[c] and Roeske[d] appear to indicate that the output of phosphorus is more affected by sleep and other factors of the daily routine and less affected by food than is the elimination of nitrogen and sulphur.

[a] New York State Sta. Tech. Bul. 1; Amer. Jour. Physiol., 16 (1906), p. 268.

[b] Amer. Jour. Physiol., 4 (1900), p. 25; 10 (1903), p. 115; 10 (1904), p. 269.

[c] Arch. Physiol. [Pflüger], 65 (1897), p. 343.

[d] Ueber den Verlauf der Phosphorsaure-Ausscheidung beim Menschen. Inaug. Diss., Griefswald, 1897.

While the nitrogen and phosphorus metabolism are thus largely independent in their general course, it is essential for the growth of new tissue that phosphorus shall be stored as well as nitrogen. Hence, when there is a storage of nitrogen sufficiently prolonged to represent tissue growth, it would seem probable that a parallel storage of phosphorus would occur. In most cases which have been studied, a prolonged gain of nitrogen has been found to be accompanied by a gain of phosphorus, and vice versa, but among adults there are many exceptions to this rule, as for example when the food is comparatively rich in phosphorus and poor in nitrogen. Under such conditions very pronounced loss of body nitrogen may be accompanied by equilibrium or even by gain of phosphorus.

The importance of phosphorus as building material for the growing organism is strikingly indicated by the way in which nature provides a milk richer in phosphorus in those species in which the growth of the young is proportionally rapid as shown by the following table based mainly upon the work of Bunge[a] and his pupils.

Relation of milk to rate of growth, in man and animals.

Species.	Time required for new-born to double the birth weight.	Proportion of principal building material in the milk.		
		Protein.	Calcium oxid.	Phosphorus pentoxid.
	Days.	*Per cent.*	*Per cent.*	*Per cent.*
Man	180	1.6	0.03	0.05
Horse	60	2.0	.12	.13
Cow	47	3.5	.16	.20
Goat	22	3.7	.20	.28
Sheep	15	4.9	.25	.29
Swine	14	5.2	.25	.31
Dog	9	7.4	.45	.51
Rabbit	6	14.4	.89	.99

TYPES OF PHOSPHOROUS COMPOUNDS IN FOODS AND THEIR NUTRITIVE RELATIONS.

The most abundant of the phosphorous compounds of food thus far studied may be grouped provisionally under four heads: (1) Inorganic phosphates; (2) simple organic derivatives of phosphoric acid and phosphates (phytin, etc.); (3) phosphorized fats (lecithin, etc.); and (4) phosphorized proteids (nucleo-proteids, nucleo-albumins).

Miescher[b] studied the formation of complex from simpler phosphorous compounds in the animal body by observations upon the Rhine salmon. During the breeding season these fish remain a long time in fresh water, taking no food but developing large masses of

[a] Abderhalden's Physiologische Chemie. Berlin, 1906, p. 433.
[b] Arch. Exp. Path. Pharm., 37 (1896), p. 100.

roe and milt at the expense of molecular tissue. This process appears to involve the formation of considerable amounts of phosphorized proteids and fats, from simple proteids and fats and inorganic phosphates. The conclusions reached by Miescher have in the main been confirmed by the recent investigations of Paton[a] in Scotland.

Maxwell[b] investigated the relations of lecithin and phosphates with reference to both plant and animal metabolism. The plant ordinarily receives its phosphorus almost entirely in the form of inorganic phosphates from which it builds up representatives of all of the above-mentioned groups of organic phosphorous compounds. At the time of Maxwell's investigations the wide distribution of notable amounts of phytin compounds was not recognized and it is probable that the phosphorus occurring in this form (especially in seeds) was considered by Maxwell as belonging to the mineral phosphates. Maxwell found in germinating seeds an increase of lecithin at the expense of phosphates [and phytin].

A similar formation of lecithin from phosphates appeared to take place in eggs during the first stages of incubation, from which it would appear that not only in the fully developed animal (as observed by Miescher) but also in the earliest metabolic activities within the egg, it is possible for animal cells to synthesize lecithins from simpler phosphorous compounds. In the later stages of incubation, as the bones of the chick developed, there was a marked decrease of lecithins and increase of phosphates, indicating that lecithin is largely concerned in the growth of even such tissues as bone.

Chiefly on account of certain peculiarities which had been observed in the artificial digestion of casein, the digestibility and nutritive value of the phosphorized radicles of phospho-proteid was for some time in doubt. In 1897, however, Marcuse,[c] working in Rohmann's laboratory, showed by a series of digestion and metabolism experiments with dogs that about 90 per cent of the phosphorus of the casein fed was absorbed and apparently well utilized.

Steinitz,[d] in continuing the work begun by Marcuse, studied especially the question whether the phospho-proteids when fed to the exclusion of phosphates were able to support a storage of phosphorus in the body. In these experiments, dogs were fed with casein (in the form of nutrose) or with ovovitellin, with the addition in each case of cane sugar and a mixture of salts containing sodium, potassium, and calcium chlorid, magnesium citrate, and iron citrate. In a control experiment the food consisted of myosin, rice starch,

[a] Jour. Physiol., 22 (1898), p. 333.
[b] Amer. Chem. Jour., 13 (1891), p. 16; 15 (1893), p. 185.
[c] Arch. Physiol. [Pflüger], 67 (1897), p. 373.
[d] Ibid., 72 (1898), p. 75.

bacon, meat extract, and meat ash with distilled water. In these experiments the phospho-proteids gave better results in the storage of phosphorus than did the control diet containing mainly simple proteids and inorganic phosphates.

Zadik[a] and Leipziger,[b] apparently working independently, though both in Rohmann's laboratory, supplemented the work of Steinitz by similar metabolism experiments in which edestin was fed. Both found that here also the phosphorus balance was distinctly less favorable upon a mixture of phosphates and simple proteids than on a diet containing phosphorized proteids in corresponding amounts.

Rohmann,[c] in summarizing and discussing the work thus carried out in his laboratory, and especially the experiments of Steinitz and Leipziger, compares the results as follows:

Calculated daily storage of phosphorus on different diets.

Characteristic food of period.	Phosphorus resorbed per kilogram body weight.	Phosphorus stored per kilogram body weight.
	Gram.	*Milligrams.*
Nutrose (casein preparation)	0.0343	8.8
Vitellin (from egg yolk)	.0283	20.9
Myosin (with phosphates)	.055	.1
Edestin (with phosphates)	.051	.1

It should be noted in connection with this method of stating the difference between the results on the two types of diet that in the experiments with the phosphorized proteids (especially in the case of vitellin) the amounts of phosphorus eliminated by the intestine were larger than with myosin and edestin and it is not improbable that at least a part of this fecal phosphorus may have been utilized by the body and then eliminated through the intestinal wall instead of through the kidneys. After making full allowance for this possibility, however, there remains a very striking difference in the phosphorus balance in favor of the phosphorized proteids as opposed to the mixtures of simple proteids with inorganic phosphates.

The storage of nitrogen was also more pronounced in the periods in which the phosphorized proteids were fed. Rohmann concludes that the nutritive functions of phosphorized and phosphorus-free proteids are not the same, the former being especially adapted to furnish the material for tissue growth.

[a] Arch. Physiol. [Pflüger], 77 (1899), p. 1.

[b] Ibid., 78 (1899), p. 402.

[c] Berlin. Klin. Wchnschr., 35 (1898), p. 789.

In this connection it is interesting to note that when casein is digested with trypsin, about two-thirds of the phosphorus remains in organic combination.[a]

Ehrström[b] experimented upon himself to determine the effect of replacing a known amount of organic food phosphorus by mineral phosphate. The organic phosphorus was taken mainly in the form of "proton," a casein preparation which was taken in bread in order to make it more palatable. The phosphorus balance was determined during three periods: (1) On freely chosen food; (2) on a diet of 1 liter milk and 500 grams proton bread; and (3) on a diet of 1 liter milk and 500 grams wheat bread and $CaHPO_4$ somewhat more than sufficient to replace the phosphorus of the proton. The result was as follows:

Daily income and outgo of nitrogen and phosphorus, as affected by substituting mineral phosphates for food phosphates. Ehrström's experiments.

Character of diet.	Duration of period.	In food.	In urine and feces.	Gain (+) or loss (−).
	Days.	*Grams.*	*Grams.*	*Grams.*
Ordinary food:				
Nitrogen	7	17.29	18.60	−1.31
Phosphorus	7	2.48	1.87	+ .61
Milk and proton bread:				
Nitrogen	6	17.85	17.27	+ .58
Phosphorus	6	2.09	1.45	+ .64
Milk and wheat bread, with $CaHPO_4$:				
Nitrogen	5	12.55	14.36	−1.81
Phosphorus	5	2.27	2.04	+ .23

Comparison of the second and third periods shows that in the latter the amount of phosphorus stored was considerably decreased, although the amount fed was increased. The interpretation of the results is somewhat complicated by the fact that the amount of phosphorus in the feces was greater in the third period than in the first; but even if it be assumed that only the phosphorus of the food minus that of the feces was available to the body the difference in the phosphorus balance is still sufficiently large to indicate that the phosphorus in the form of phospho-proteid was of distinctly greater nutritive value than that in the form of phosphate.

A further confirmation of this fact is found in the work of Gumpert,[c] who, in an experiment upon a man, found that 1.88 grams of phosphoric anhydrid given mainly in the form of casein kept the subject in practical equilibrium, whereas the substitution of meat for the casein, while decreasing the amount of phosphoric anhydrid in the

[a] Bayliss and Plimmer in Cohen's Organic Chemistry, p. 430; Jour. Physiol., 33 (1906), p. 439.

[b] Skand. Arch. Physiol., 14 (1903), p. 82.

[c] Med. Klinik., 1 (1905), p. 1037.

food by only 0.08 gram, caused a loss of 0.25 to 0.40 gram from the body, a result which is evidently due to the fact that the phosphorus of the casein was of greater nutritive value than that of the meat, about half of the latter being in the form of phosphates.

It does not follow, however, that the phosphorus of phosphates is without nutritive value, nor even as concluded by Zadik,[a] that the body is incapable of utilizing it for tissue growth. Keller,[b] in a study of the phosphorus metabolism of young children, found evidence that storage of phosphorus was favored by food which contained a liberal supply of phosphates in addition to phospho-proteids and phosphorized fats. Ehrström, also, in the discussion of his results above quoted, assigns to the inorganic phosphates a distinct value in nutrition, and from the data of a recent investigation by Von Wendt[c] it may be seen that the loss of phosphorus occurring on a diet poor in ash was greatly reduced when dicalcium phosphate was added to the ration without any change in the food consumed. The inorganic phosphates appear also to have a prominent part in maintaining the proper degree of neutrality in the body fluids, as shown by Henderson and his associates.[d]

Active investigations regarding the nutritive values of the phytin compounds and of the phosphorized fats being now in progress, any attempt to summarize the knowledge on these points would be premature at this time.

In general it appears that all four types of phosphorus compounds are utilized in nutrition, but that considerable differences in nutritive value probably exist.

It is doubtless largely for this reason that experiments upon the intake and output of phosphorus have given such variable indications as to the amount required for the maintenance of equilibrium in man. One subject has shown equilibrium on a diet furnishing 0.82 gram phosphorus (equivalent to 1.88 grams P_2O_5) per day, and another has lost phosphorus while on a diet which furnished 2.07 grams (equivalent to 4.74 grams of P_2O_5) per day. Probably also the phosphorus output like the nitrogen output is governed to some extent by the previous habit of the organism, so that the balance of intake and output for a short period may not show the actual phosphorus requirement, but something between this and the amount ordinarily eaten.

---

[a] Arch. Physiol. [Pflüger], 77 (1899), p. 1.

[b] Arch. Kinderheilk., 29 (1900), p. 1.

[c] Skand. Arch. Physiol., 17 (1905), p. 211.

[d] Amer. Jour. Physiol., 15 (1906), p. 257; 18 (1907), pp. 113, 250; Jour. Med. Research, 16 (1907), p. 1; Abs. in Chem. Abst., 1 (1907), pp. 1020, 1292.

Without attempting any discussion of individual experiments upon the phosphorus requirement (satisfactory interpretation of which must await further knowledge of the distribution and relative amounts of the different types of phosphorus compounds in foods), the general bearing of such experiments will be considered after the metabolism experiments of the present investigation have been described.

METABOLISM EXPERIMENTS OF THE PRESENT INVESTIGATION.

The present investigation included 6 metabolism experiments, each of three days' duration, in which the balance of intake and output was determined for calcium, magnesium, and phosphorus. In three of the experiments the metabolism of iron was also studied, and the experimental conditions have been fully described and the iron balances discussed in a previous publication.[a] Such general details of these three experiments as are essential to the reporting of the studies of calcium and magnesium are summarized in the present publication. In all six experiments the subject was the same—a healthy man engaged in laboratory work. The diet of each experiment was decided upon in advance and was identical for each of the three days of each experiment.

Each experimental day began at 7 a. m. and the food was taken in three nearly equal meals, at 7.30 a. m., and 12.20 and 6.30 p. m. The urine of each experimental day was mixed, weighed, and sampled for analysis and for the preparation of a composite sample representing the entire experiment. The feces for each 3-day period were marked off by means of pure charcoal taken with the food at breakfast of the first day of each experiment and of the day following its completion. In order to minimize the danger of accidental contamination, the feces were usually received directly in platinum dishes and burned to ash without any previous manipulation. The nitrogen content of the feces was therefore not actually determined, but was estimated from the results of previous investigations.

PREPARATION AND SAMPLING OF FOOD MATERIALS.

The bread used in all these experiments was one of the common brands of biscuit or "soda crackers" sold in small sealed packages. The contents of several packages were mixed and sampled and portions weighed out for each day's dietary in advance.

In those experiments in which milk formed a part of the diet, it was obtained in sealed quart bottles from one of the large dealers in New York City and was doubtless from the mixed product of many

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 185.

cows. As a rule, a fresh bottle was opened at each meal, the contents thoroughly mixed, the specific gravity determined, and portions withdrawn at once for consumption and analysis. Since the specific gravity was found to be practically uniform, indicating that all the milk was of the same general quality, composite samples were prepared for analysis by mixing equal amounts from each bottle used.

Coagulated white of egg was used in the second experiment. This was obtained from eggs which had been kept in boiling water for about 30 minutes. The coagulated white of each egg was carefully removed and freed as thoroughly as possible from all traces of yolk or shell. Any dark specks noticed in the body of the white were also removed. The coagulated whites were then mixed in glass-stoppered bottles and portions were weighed for analysis and for each day's dietary.

METHODS OF ANALYSIS.

For the determination of moisture, fat, and ash the methods of the Association of Official Agricultural Chemists were used.[a] Nitrogen was determined by the Dyer modification of the Kjeldahl method, which has been found by repeated trials in this laboratory [b] to give slightly higher and more accurate results than those obtained by following exactly the directions of the official methods. Protein was estimated in all cases by multiplying the amounts or percentages of nitrogen by the factor 6.25. Phosphorus was determined by precipitating first as ammonium phosphomolybdate and finally as magnesium ammonium phosphate, organic matter having been destroyed before the first precipitation either by boiling with sulphuric and nitric acids, by burning with sodium carbonate (using nitrate if necessary to facilitate the oxidation), or in the case of feces, of which the ash was porous and alkaline, by simple ignition.

In the determination of calcium and magnesium in foods and feces the substances were burned in platinum and the ash dissolved in water and hydrochloric acid. To the solution ammonia was added until a permanent precipitate formed. Enough acetic acid was then added to just dissolve this precipitate, then also about 0.5 gram ammonium acetate; the solution was warmed and a saturated solution of ammonium oxalate added in slight excess, then allowed to stand 12 hours, filtered, and washed with water containing ammonium oxalate, ignited and weighed as CaO. The filtrate was then made slightly alkaline with ammonia, then hydrogen disodium phosphate added in slight excess, and allowed to stand in the cold for 1 hour. Then 10 cubic centimeters of 0.90 specific gravity ammonia were added for every 100 cubic centimeters of solution and

[a] U. S. Dept. Agr., Bur. Chem. Bul. 46, revised.

[b] Jour. Amer. Chem. Soc., 26 (1904), pp. 367, 1469.

allowed to stand overnight. The solution was filtered and the precipitate washed with 3 per cent ammonia solution, dried, separated from the paper, ignited, and weighed as $Mg_2P_2O_7$. In urine calcium and magnesium were determined by the usual gravimetric methods as given in Thierfelder's revision of Hoppe-Seyler's[a] volume on chemical analysis.

COMPOSITION OF FOOD MATERIALS.

The food materials used in the six metabolism experiments yielded, when analyzed by the methods above outlined, the following results:

Composition of food materials.

Laboratory No.	Food material.	Water.	Protein.	Fat.	Carbohydrates.	Calcium oxid.	Magnesium oxid.	Phosphorus.	Nitrogen.
		Per cent.	*P. ct.*	*P. ct.*	*Per cent.*	*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*
701	Crackers	3.55	9.75	9.95	75.33	0.0282	0.0176	0.0892	1.56
702	Milk	87.04	3.23	4.11	4.88	.1739	.0173	.0941	.517
703	Egg, white	86.70	11.13	.27	....	.0104	.0170	.0110	1.78
831	Crackers	5.48	9.70	9.64	73.80	.0285	.0173	.0891	1.552
832	Milk	87.14	3.30	3.89	4.93	.1729	.0152	.0944	.528
833	Butter[a]	(a)	.43	(a)	....	.0216	.0011	.0136	.069
834	Milk	87.40	3.18	3.91	4.79	.1635	.0155	.0944	.508
835	.....do	87.25	3.23	3.95	4.86	.1586	.0156	.0920	.517

[a] The sample of butter was lost after determination of protein and mineral constituents, but before determinations of water and fat had been made. In calculating the fuel value of the diet in which butter was used it is assumed that the butter contained an average amount of fat and was of average fuel value.

DETAILS OF METABOLISM EXPERIMENT No. 1.

The experiment was begun at 7 a. m. December 30, 1905, and continued 3 days.

The weight of the subject (without clothing) was 65 kilograms (143 pounds) at the beginning and 62.5 kilograms (137.5 pounds) at the end of the experiment. It may be noted that the usual weight of this subject (without clothing) is 63 to 66 kilograms in winter and 60 to 63 kilograms in summer.

The daily food consisted of 150 grams of bread (crackers) and 1,500 grams of milk. The crackers furnished 14.6 grams protein, 14.9 grams fat, and 113 grams carbohydrates. The milk furnished 48.4 grams protein, 61.7 grams fat, and 73.2 grams carbohydrates. The total nutritive value of the diet was therefore 63 grams protein, 76.6 grams fat, and 186.2 grams carbohydrates, the fuel value being 1,690 calories.

[a] Hoppe-Seyler, Chemischen Analyse. Berlin, 1903, 7 ed., p. 346; 8 ed., 1909, p. 570.

The data regarding the income and outgo of mineral constituents and nitrogen are given in the following table:

Income and outgo of mineral constituents in metabolism experiment No. 1 (serial No. 11).

Kind of material.	Calcium oxid.	Magnesium oxid.	Phosphorus.	Nitrogen.
Food per day:	*Grams.*	*Gram.*	*Grams.*	*Grams.*
Bread (crackers)	0.042	0.026	0.134	2.34
Milk	2.609	.260	1.412	7.76
Total daily income	2.651	.286	1.546	10.10
Feces:				
Total, for 3 days	5.630	.510	1.710	(1.38)
Average per day	1.880	.170	.570	(.46)
Urine:				
First day (December 30 to January 1)	....	....	.850	12.52
Second day (January 1-2)	....	....	1.110	13.56
Third day (January 2-3)	....	....	1.140	13.19
Total, for 3 days	.630	.570	3.100	39.27
Average per day	.210	.190	1.030	13.09
Total outgo per day	2.090	.360	1.600	13.55
Gain (+) or loss (−) per day	+.561	−.074	−.054	−3.45

In this experiment, therefore, there was a considerable storage of calcium, slight losses of magnesium and phosphorus, and a considerable loss of nitrogen. The calcium, magnesium, and phosphorus balances will be discussed beyond in connection with those of the other experiments. The loss of nitrogen was due rather to the low fuel value than to the low protein of the diet, since experiment has shown that about 65 grams of protein suffice for the maintenance of nitrogen equilibrium in this subject when the food is of adequate fuel value.

DETAILS OF METABOLISM EXPERIMENT No. 2.

This experiment, which followed the preceding one without intermission, was begun at 7 a. m. January 3, 1906, and continued for 3 days.

The weight of the subject (without clothing) was approximately 62.5 kilograms (137.5 pounds) both at the beginning and at the end of the experiment.

The daily food consisted of 400 grams of bread (crackers) and 250 grams of coagulated white of egg. This food was taken with about 1,000 grams of distilled water. The crackers furnished 39 grams protein, 39.8 grams fat, and 301.3 grams carbohydrates. The egg white furnished 27.8 grams protein and 0.7 gram fat. The total nutritive value of the diet was therefore 66.8 grams protein, 40.5 grams fat, and 301.3 grams carbohydrates, the total fuel value being 1,833 calories.

The data recording the income and outgo of mineral constituents and nitrogen are given in the following table:

Income and outgo of mineral constituents in metabolism experiment No. 2 (serial No. 12).

Kind of material.	Calcium oxid.	Magnesium oxid.	Phosphorus.	Nitrogen.
Food per day:	*Grams.*	*Gram.*	*Grams.*	*Grams.*
Bread (crackers)	0.113	0.070	0.357	6.24
Egg white	.026	.043	.027	4.45
Total daily income[a]	.139	.113	.384	10.69
Feces:				
First day (January 3–4)	.480	.050	.170	....
Second day (January 4–5) } Third day (January 5–6) }	.960	.190	.500	....
Total for 3 days	1.440	.240	.670	(2.25)
Average per day	.480	.080	.223	(.75)
Urine:				
First day (January 3–4)	....	....	.900	13.06
Second day (January 4–5)	....	....	.740	13.75
Third day (January 5–6)	....	....	.620	12.83
Total for 3 days	.290	.390	2.260	39.63
Average per day	.097	.130	.753	13.21
Total outgo per day	.577	.210	.976	13.96
Loss per day	.438	.097	.592	3.27

[a] About 1,000 grams of distilled water were taken daily with this diet.

The diet of the second experiment, while slightly higher in protein and fuel value than that of the first, contained only about one-twentieth as much lime, two-fifths as much magnesia, and one-fourth as much phosphorus. The diet (bread, egg white, and distilled water) was rather distasteful and appeared to be the cause of a slight looseness of the bowels, which appeared at the end of this period.

The balances show a moderate loss of magnesium and considerable losses of calcium, phosphorus, and nitrogen. At the close of this experiment the diet was increased to 2,560 calories with only a slight increase of protein, whereupon the loss of nitrogen fell at once to only 0.2 gram per day, showing that the negative nitrogen balance was attributable to insufficient fuel value.

DETAILS OF METABOLISM EXPERIMENT No. 3.

This experiment was begun at 7 a. m. June 3, 1906, and continued 3 days. In order that the bodily condition of the subject should be as nearly as possible the same as in the second experiment, the diet of the 3 days preceding the third experiment was the same as in the first experiment, viz, 150 grams of crackers and 1,500 grams of milk per day.

The weight of the subject (without clothing) was approximately 62.7 kilograms (138 pounds) at the beginning and 61.8 kilograms (136 pounds) at the end of the experiment. The initial weight was

therefore practically the same in this as in the second experiment, and the loss of 0.9 kilogram during the 3 days was probably due as largely to the hot weather as to the deficient fuel value of the diet.

The daily diet consisted of 450 grams of the same lot of soda crackers as were used in the first and second experiments, with an average of 1,200 grams of distilled water per day. The crackers supplied 43.9 grams protein, 44.7 grams fat, and 339 grams carbohydrates, the total fuel value being 1,930 calories.

The average daily income and outgo of mineral constituents and nitrogen are shown in the following table:

Income and outgo of mineral constituents in metabolism experiment No. 3 (serial No. 13).

Kind of material.	Calcium oxid.	Magnesium oxid.	Phosphorus.	Nitrogen.
	Grams.	*Gram.*	*Grams.*	*Grams.*
Food per day:				
Bread (crackers)	0.126	0.079	0.401	7.02
Distilled water	....	....	....	....
Total daily income	.126	.079	.401	7.02
Feces:				
Total for 3 days	3.690	.379	1.355	....
Average per day	1.230	.126	.452	(.70)
Urine:				
First day (June 3–4)	.062	.086	.986	10.64
Second day (June 4–5)	.044	.095	.622	10.46
Third day (June 5–6)	.056	.098	.476	9.77
Total for 3 days	.162	.279	2.084	30.87
Average per day	.054	.093	.695	10.29
Total outgo per day	1.284	.219	1.147	10.99
Loss per day	1.158	.140	.746	3.97

Here, with the amounts of lime, magnesia, and phosphorus about the same as in the second experiment, the losses are in each case considerably greater and in the case of lime conspicuously so, the excretion of lime being more than twice as great as in the second experiment.

During this experiment the food did not become so distasteful as during the second, but there was some lack of appetite and at times a slight feeling of fullness and thirst after meals. There was also in this, as in the second experiment, a slight tendency toward looseness of the bowels.

DETAILS OF METABOLISM EXPERIMENT No. 4.

This experiment followed the preceding one without intermission and continued for 3 days, June 6–9, 1906.

The weight of the subject (without clothing) was approximately 61.8 kilograms (136 pounds) at the beginning and 63.2 kilograms (139 pounds) at the end of the experiment.

The diet consisted of 450 grams "soda crackers" (of the same kind as in the earlier experiments but from a different lot, No. 831), 450 grams milk (No. 832), 75 grams butter (No. 833), and 1,500 grams of hydrant water per day. The crackers furnished 43.7 grams of protein, 43.4 grams of fat, and 332 grams of carbohydrates. The milk furnished 14.9 grams of protein, 17.5 grams of fat, and 22 grams of carbohydrates. The butter furnished 0.3 gram protein and 63.8 grams of fat. The total food value was therefore 58.9 grams of protein, 124.7 grams of fat, and 354 grams of carbohydrates, yielding a total of 2,774 calories per day.

The data of income and outgo of calcium, magnesium, phosphorus, and nitrogen during this experiment are given in the following table:

Income and outgo of mineral constituents in metabolism experiment No. 4 (serial No. 14).

Kind of material.	Calcium oxid.	Magnesium oxid.	Phosphorus.	Nitrogen.
Food per day:	*Grams.*	*Gram.*	*Grams.*	*Grams.*
Bread (crackers)	0.128	0.078	0.401	6.98
Milk	.778	.068	.425	2.38
Butter	.017	.001	.010	.05
Water	.025	.013	....	....
Total daily income	.948	.160	.836	9.41
Feces:				
Total for 3 days	2.147	.160	.678	....
Average per day	.716	.053	.226	.77
Urine:				
First day (June 6-7)	.063	.102	.513	9.59
Second day (June 7-8)	.111	.139	.690	9.76
Third day (June 8-9)	.149	.155	.773	9.31
Total for 3 days	.323	.396	1.976	28.66
Average per day	.108	.132	.659	9.55
Total outgo per day	.824	.185	.885	10.32
Gain (+) or loss (−) per day	+.124	−.025	−.049	−.91

Here the fuel value of the diet was adequate and the subject was gaining in weight. The intake of 58.9 grams of protein, 0.836 gram of phosphorus (equivalent to 1.91 grams of P_2O_5), and 0.16 gram of magnesia was not quite sufficient for equilibrium, although in each case the body had received during the preceding period an even smaller allowance. A daily intake of 0.948 gram of lime resulted, however, in an average storage of 0.124 gram, or about one-eighth of the amount taken in the food.

DETAILS OF METABOLISM EXPERIMENT No. 5.

This experiment began on the morning of June 9, 1906, following experiment No. 4 without intermission, and continued for 3 days.

The weight of the subject (without clothing) was approximately 63.2 kilograms (139 pounds) at the beginning and 62.5 kilograms (137½ pounds) at the end of the experiment.

The diet consisted of 300 grams crackers (No. 831), 450 grams milk (No. 834), and 75 grams butter (No. 833) per day, with which was taken 1,000 cubic centimeters of hydrant water. The crackers furnished 29.1 grams protein, 28.9 grams fat, and 221 grams carbohydrates; the milk 14.3 grams protein, 17.6 grams fat, and 22 grams carbohydrates; the butter 0.3 gram protein and 63.8 grams fat. The total food was therefore 43.7 grams protein, 110.3 grams fat, and 243 grams carbohydrates, yielding in all 2,140 calories per day.

The data of income and outgo of calcium, magnesium, phosphorus, and nitrogen are given for this period in the following table:

Income and outgo of mineral constituents in metabolism experiment No. 5 (serial No. 15).

Kind of material.	Calcium oxid.	Magnesium oxid.	Phosphorus.	Nitrogen.
Food per day:	*Grams.*	*Gram.*	*Grams.*	*Grams.*
Bread (crackers)	0.096	0.052	0.267	4.66
Milk	.736	.070	.425	2.29
Butter	.017	.001	.010	.05
Water	.017	.009	....	....
Total daily income	.866	.132	.702	7.00
Feces:				
Total for 3 days	1.745	.138	.480	....
Average per day	.582	.046	.160	.54
Urine:				
First day (June 9-10)	.174	.116	.848	7.84
Second day (June 10-11)	.211	.155	.839	9.25
Third day (June 11-12)	.180	.144	.684	8.52
Total for 3 days	.565	.415	2.371	25.61
Average per day	.188	.138	.790	8.54
Total outgo per day	.770	.184	.950	9.08
Gain (+) or loss (−) per day	+.096	−.052	−.248	−2.08

Here, with a somewhat decreased intake of each of the elements studied as well as of the fuel value of the diet the storage of calcium continued at a somewhat decreased rate, and the losses of magnesium, phosphorus, and nitrogen continued at an increased rate as compared with the preceding experiment.

DETAILS OF METABOLISM EXPERIMENT No. 6.

This experiment followed that last described without intermission and continued for 3 days, June 12–15, 1906.

The weight of the subject was approximately 62.5 kilograms (137½ pounds) at the beginning and 62.3 kilograms (137 pounds) at the end of the experiment.

The diet consisted of 300 grams crackers (No. 831) and 1,350 grams milk (No. 835) per day. The crackers furnished 29.1 grams protein, 28.9 grams fat, and 221 grams carbohydrates; the milk, 43.6 grams protein, 53.3 grams fat, and 64 grams carbohydrates; the total food,

72.7 grams protein, 82.2 grams fat, and 285 grams carbohydrates; yielding in all 2,170 calories per day.

The data of income and outgo of calcium, magnesium, phosphorus, and nitrogen are given in the following table:

Income and outgo of mineral constituents in metabolism experiment No. 6 (serial No. 16).

Kind of material.	Calcium oxid.	Magnesium oxid.	Phosphorus.	Nitrogen.
Food per day:	*Grams.*	*Gram.*	*Grams.*	*Grams.*
Bread (crackers)	0.096	0.052	0.267	4.66
Milk	2.141	.211	1.242	6.98
Total daily income	2.237	.263	1.509	11.64
Feces:				
Total for 3 days	5.420	.422	1.507	....
Average per day	1.807	.141	.502	(.68)
Urine:				
First day (June 12-13)	.301	.195	.988	10.70
Second day (June 13-14)	.322	.165	1.012	10.02
Third day (June 14-15)	.297	.177	.976	11.05
Total for 3 days	.920	.537	2.976	31.77
Average per day	.307	.179	.992	10.59
Total outgo per day	2.114	.320	1.494	11.27
Gain (+) or loss (−) per day	+.123	−.057	−.015	+.37

Here the fuel value was practically the same as in the preceding experiment, but the protein and ash constituents of the food were considerably increased. There was nearly constant body weight and approximate equilibrium of nitrogen and phosphorus and a small loss of magnesium. Although the calcium of the food was more than doubled, the amount stored in the body was but little increased, the output having risen with the intake, as might be expected, in view of the fact that the body was already sufficiently supplied, having received for six days previously somewhat more calcium than was actually required for the maintenance of equilibrium.

That the output of calcium can follow the intake so closely when more than the required amount is fed should tend to dispel any fear of an undue accumulation of lime in the body as the result of using food rich in calcium compounds.

COMPARISON OF BALANCES FOR LIME, MAGNESIA, AND PHOSPHORUS.

For convenience of comparison the lime, magnesia, and phosphorus balances for the 6 experiments are brought together in the table which follows.

Daily balances of income and outgo of lime, magnesia, and phosphorus.

Experiment No.	Calcium oxid.			Magnesium oxid.			Phosphorus.		
	Income.	Outgo.	Balance.	Income.	Outgo.	Balance.	Income.	Outgo.	Balance.
	Grams.	*Grams.*	*Grams.*	*Gram.*	*Gram.*	*Gram.*	*Grams.*	*Grams.*	*Gram.*
1	2.65	2.09	+0.56	0.29	0.36	−0.07	1.55	1.60	−0.05
2	.14	.58	− .44	.11	.21	− .10	.38	.97	− .59
3	.12	1.28	−1.16	.08	.22	− .14	.40	1.15	− .75
4	.94	.82	+ .12	.16	.19	− .03	.83	.88	− .05
5	.87	.77	+ .10	.13	.18	− .05	.70	.95	− .25
6	2.23	2.11	+ .12	.26	.32	− .06	1.51	1.49	+ .02

Assuming, as is customary in these investigations, that of any given element the "requirement" is the amount found by experiment to be sufficient for the maintenance of equilibrium under normal conditions, it is evident that since there was a loss of magnesium in each of the 6 experiments the magnesium requirement can not be deduced from them. It is also apparent that only those experiments in which there was a reasonably close approach to equilibrium of lime or of phosphorus can be taken as indicating the lime or phosphorus requirement.

Considering the great number of experiments which have been found necessary to establish the nitrogen requirement of man, it is evident that many more experiments should be made before attempting to draw conclusions regarding the requirements for calcium or for phosphorus. All that can be done at present is to point out the more obvious indications of the data now at hand.

CALCIUM REQUIREMENT.

In experiment No. 5 the body received 0.87 gram CaO and excreted only 0.77 gram, indicating that its requirement was not greater than the latter figure. On the other hand, in experiment No. 2, where the food furnished only 0.14 gram, the man nevertheless excreted 0.58 gram, indicating that at least the latter amount was required in his nutrition. These results therefore indicate that the lime requirement of this subject lay between 0.58 and 0.77 gram, though doubtless at other times and on other diets somewhat different figures might be obtained.

Among the earlier experiments reviewed above it is found that Bertram apparently required only 0.4 gram of CaO, and Gramatchikov also reports one case of equilibrium on 0.4 gram, while Renvall [a]

[a] From the data of one experimental day, which he believed to represent his requirement more accurately than the average, Renvall estimated his requirement at 0.95 gram CaO.

required 0.83 gram calcium equivalent to 1.16 grams CaO per day, and Von Wendt's requirement appeared to be somewhere between 0.4 and 0.85 gram CaO.

It appears, therefore, that a calcium requirement equivalent to about 0.7 gram CaO per day is indicated by the results of the present study and also approximates the average of earlier investigations, but further experiments are needed before any such estimate can be regarded as satisfactory. Experiments for this purpose must, of course, include a complete determination of the calcium balance, for while the amount of calcium found in the urine will usually be small it varies so greatly in absolute as well as in relative amount that no assumption regarding the distribution of calcium between feces and urine can be justified. In the experiments here reported from 3.9 to 23.7 per cent of the eliminated calcium appeared in the urine, but in one of Renvall's experiments the proportion was 64.3 per cent. In a large majority of the experiments by Renvall, Von Wendt, and the writers, the feces have contained between 60 and 90 per cent and the urine between 10 and 40 per cent of the eliminated calcium.

PHOSPHORUS REQUIREMENT.

In attempting to draw inferences in regard to the phosphorus requirement, greater difficulties are experienced than in the case of calcium. The closest agreement between income and outgo of phosphorus appears in the results for experiment No. 6, where there was equilibrium on 1.5 grams phosphorus per day. But in experiment No. 4 the same subject was very nearly in equilibrium when metabolizing only 0.88 gram per day. The requirement would therefore appear to lie anywhere between 0.9 and 1.5 grams. This wide variation is probably due in part at least to a difference in diet. In experiment No. 4 the phosphorus was obtained about equally from bread and from milk, while in experiment No. 6 more than four-fifths was derived from milk and less than one-fifth from bread. It is now believed that in bread nearly all of the phosphorus is in organic combination, while milk contains, in addition to its important organic compounds of phosphorus, a considerable proportion of simple phosphates. Since phosphorus appears to be of greater nutritive value in its organic than in its inorganic compounds, this is the probable explanation of the fact that much larger amounts of phosphorus were apparently required for approximate equilibrium in experiments Nos. 1 and 6 than in experiment No. 4.

Doubtless, also, the previous habit of the subject plays a part in the metabolism of phosphorus, as it is well known to do in the metabolism of nitrogen. There might not have been such a close approach to equilibrium in experiment No. 4 if the subject had not been for some

days previously on food of low phosphorus content, and on the other hand the apparent phosphorus requirement of a man who had been living on a liberal mixed diet may be greater than the actual requirement as it would be found by gradually accustoming the subject to a diminished intake.

Hence an attempt to set a figure for the phosphorus requirement presents difficulties analogous to those surrounding the establishment of the protein requirement, and is rendered still more uncertain by the fact that much fewer experiments have been made upon the phosphorus metabolism than upon the metabolism of nitrogen. At present it can only be said that the data now available[a] indicate that a healthy man, by accustoming himself to a low phosphorus intake or by the selection of food containing phosphorus almost entirely in organic combination, may maintain equilibrium on a diet furnishing about 0.9 gram phosphorus, or about 2 grams P_2O_5, but that the maintenance of equilibrium at the normal level of a full diet, so as to insure the carrying of a full normal store of phosphorus compounds in the body, appears to call for the intake of about 1.5 grams of phosphorus, or about 3.5 grams of P_2O_5, per day.

Further experiments upon the phosphorus requirement are greatly needed, and these should be planned with due reference to the nature of the phosphorus compounds present in the different food materials. It need scarcely be added that these should be complete balance experiments, for in man the distribution of the eliminated phosphorus between urine and feces is so variable that no safe inferences regarding requirements can be drawn from any experiments except those in which the output by both feces and urine is accurately determined. Ehrström[b] has shown, by comparing the results of his own experiments upon phosphorus metabolism with those of Loewi[c] and Siven,[d] that in experiments with healthy men on normal diets the amount of phosphorus in the feces as compared with the amount in the food may vary at least from 12.2 to 71.8 per cent. In some of the experiments of Tigerstedt and Von Wendt, and in one of those here reported, the feces contained more phosphorus than the food. Of the total eliminated phosphorus in the six experiments here reported the feces contained 16.8 to 39.3 per cent and the urine 60.7 to 83.2 per cent.

[a] In addition to the experiments here reported the data of intake and output in about 75 earlier experiments have also been taken into account. Only a few of these, however, were arranged primarily with a view to the determination of the phosphorus requirement.

[b] Skand. Arch. Physiol., 14 (1903), p. 82.

[c] Arch. Expt. Path. u. Pharmakol., 45 (1900–1901), p. 157.

[d] Skand. Arch. Physiol., 11 (1901), p. 308.

CALCIUM, MAGNESIUM, AND PHOSPHORUS IN FOOD MATERIALS AND IN TYPICAL AMERICAN DIETARIES.

In any general study of the food requirements of the human body it is important to supplement the results obtained from metabolism experiments by careful estimates of the actual amounts consumed by typical people living under normal conditions and with freely chosen food. In previous publications of this Office there have been given the detailed results of several hundreds of such dietary studies in which account was taken of the amounts of protein, fats, and carbohydrates consumed. In connection with a study of iron in food and its functions in nutrition, twenty of these dietaries were selected as typical, and the recorded data of food consumption were taken in connection with the recently determined percentages of iron in food materials as the basis of estimation of the actual amounts of food-iron in the ordinary diet of typical American families.

In a similar manner the calcium, magnesium, and phosphorus contents have now been estimated (1) of the same twenty typical family dietaries; (2) of 5 dietaries studied at the Maine State College in 1895[a] in cooperation with this Office, in which an attempt was made to control the sources of protein in the food consumed by a large college club; and (3) of an individual experimental dietary study made in New York City in 1906 in the course of the investigation upon iron in food and nutrition,[b] to which reference has already been made.

Comparatively few satisfactory data relating to the calcium, magnesium, and phosphorus contents of the edible portion of food material could be found, partly because the recorded analyses of food ash are sometimes of doubtful accuracy, but especially because ash analyses of food materials have most commonly been made by agricultural chemists, whose interest lay in determining the amounts of ash constituents removed from the soil by the crop, and who therefore analyzed the whole of the material removed from the soil or from the farm without always separating the edible from the inedible portion.

In order to guard against errors from such sources, ash analyses found in the literature have not been accepted in any important case without verification. One or more samples of each food material which furnishes an important proportion of the ash constituents of any given dietary has been analyzed in connection with this investigation, and the results thus obtained have been compared, and in most cases averaged, with any previously recorded results which appeared to be trustworthy. These results, which have been used in calculating the data of the dietary studies which are given in the table on page 41,

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 37.
[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 185.

are therefore either the results of analyses made in connection with this study or are the average of data thus obtained and of such earlier data as appeared to be reasonably satisfactory.

In all cases in which it has been necessary to estimate the composition of dried or canned material from that of the corresponding fresh food, or vice versa, the computations have been based either upon moisture determinations made in the course of the analysis or upon the data contained in the standard compilation of analyses of American food materials.[a] In the case of jellies, jams, and other forms of fruits preserved with sugar, the ash contents have been assumed to average two-thirds as much as in the original fresh fruits.

The table which follows gives the data regarding the calcium, magnesium, and phosphorus content of food materials.

Ash constituents of food materials—Estimated average figures used in computing results of dietary studies.

Food materials.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
ANIMAL FOODS, CEREALS, ETC.	*Per cent.*	*Per cent.*	*Per cent.*
Meats	(b)	(b)	(b)
Fish and shellfish	(c)	(c)	(c)
Eggs	0.100	0.015	0.367
Butter (and butterine)	.022	.001	.031
Buttermilk (estimated as milk)	.172	.018	.217
Cheese	1.240	.049	1.490
Cottage cheese	.100	.015	.455
Milk, condensed[d]	.430	.045	.542
Milk, whole	.172	.018	.217
Cream	.147	.015	.186
Barley, pearled	.025	.100	.460
Corn meal	.009	.132	.458
Hominy (as old process meal)	.014	.196	.708
Oatmeal (including rolled oats, etc.)	.078	.249	.974
Rice	.012	.060	.198
Wheat flour (crackers and macaroni)	.028	.026	.216
Ginger snaps (assumed)	.040	.030	.250
Graham flour and entire wheat flour (assumed)	.037	.150	.660
Flaked wheat breakfast food	.043	.239	.946
Bread used in dietary study No. 486	.082	.080	.279
Bread	.021	.019	.162
Chocolate	.141	.483	.897
Molasses	.355	.176	.132
Maple sirup	.123	.100	.100
Honey	.005	.030	.065
VEGETABLES.			
Asparagus	.038	.017	.094
Beans, pea, dried	.215	.252	1.098
Beans, kidney, dried	.226	.261	1.235
Beans, Lima, dried	.106	.311	.752
Beans, string, fresh	.073	.050	.091
Beets	.019	.029	.095
Cabbage	.058	.021	.081
Carrots	.077	.032	.094
Celery	.094	.027	.100
Corn, canned or green	.045	.070	.257
Cucumbers	.028	.018	.052
Eggplant	.017	.037	.079
Greens, turnip tops	.508	.036	.098

[a] U. S. Dept. Agr., Office Expt. Stas., Bul. 28, revised.

[b] Meats were estimated to contain per 100 grams protein, 0.076 gram CaO, 0.19 gram MgO, 2.3 grams P_2O_5.

[c] Fish and shellfish were estimated to contain per 100 grams protein, 0.18 gram CaO, 0.23 gram MgO, 2.8 grams P_2O_5.

[d] Estimated as equivalent to 2.5 times its weight of whole milk in ash constituents.

Ash constituents of food materials—Estimated average figures used in computing results of dietary studies—Continued.

Food materials.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
VEGETABLES—continued.	*Per cent.*	*Per cent.*	*Per cent.*
Greens, soup greens (assumed)	0.080	0.030	0.085
Horseradish	.136	.038	.127
Lettuce	.045	.012	.073
Onions	.040	.015	.080
Parsnips	.076	.044	.183
Peas, dried	.137	.204	.875
Peas, canned	.023	.034	.142
Potatoes	.016	.040	.144
Potatoes, sweet	.025	.019	.080
Pumpkins	.032	.014	.125
Radishes	.025	.019	.050
Rhubarb	.090	.010	.103
Ruta-bagas	.103	.031	.129
Spinach	.064	.053	.103
Tomatoes	.019	.016	.045
Tomatoes, canned	.019	.016	.045
Turnips	.087	.029	.117
Vegetable soup (canned condensed)	.026	.021	.116
Water cress	.259	.046	.066
FRUITS.			
Apples	.011	.014	.026
Apples, evaporated	.037	.054	.121
Apricots	.021	.019	.058
Bananas	.009	.035	.063
Blackberries	.079	.037	.083
Blueberries	.045	.015	.046
Cherries	.026	.027	.075
Cranberries	.021	.012	.064
Currants	.046	.026	.070
Currants, dried	.169	.076	.178
Dates	.104	....	.122
Figs, dried	.280	.144	.332
Grapes	.014	.019	.065
Grape jelly	.009	.015	.043
Grape fruit	.029	.015	.043
Huckleberries	.037	.027	.060
Oranges	.043	.016	.048
Peaches, dried	.048	.093	.334
Peaches	.015	.015	.049
Pears	.018	.014	.041
Pears, canned	.008	.007	.020
Pineapples	.058	.027	.022
Plums	.022	.019	.038
Plums, jam, canned	.014	.012	.025
Prunes	.063	.084	.204
Raisins	.042	.070	.240
Raspberries	.072	.037	.093
Strawberries	.057	.036	.068
Watermelons	.018	.022	.034
MISCELLANEOUS.			
Pie, apple (assumed)	.030	.030	.100
Pie, cream (assumed)	.040	.030	.150
Pie, custard (assumed)	.060	.030	.200
Pie, mince	.044	.037	.191
Pie, squash	.030	.015	.150

DIETARY STUDIES IN PROFESSIONAL MEN'S FAMILIES.

DIETARY STUDY OF A LAWYER'S FAMILY IN PITTSBURG (NO. 43).[a]

This study was made in the winter of 1895 in the family of a lawyer in comfortable circumstances, and continued 30 days. The family consisted of 2 men, 6 women, a girl 12 years old, and frequent visitors.

[a] For full data regarding the amount and composition of the food eaten, see U. S. Dept. Agr., Office Expt. Stas. Bul. 52, p. 12.

The total number of meals taken was estimated as equivalent to those of one man for 227 days, and the total food eaten, calculated per man per day, furnished 91 grams of protein and 3,280 calories at a cost of 22.3 cents.

In calculating the amounts consumed per man per day in the different dietaries, use has been made in all cases of the conventional assumption as to the relative amounts of food eaten by women and children as compared with men. These have been summarized in an earlier publication.[a]

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 43.

Food materials and weight of edible portion.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Beef, veal, lamb, and pork (total meat protein, 7,900 grams)	6.004	15.010	181.700
Salmon, 1,215 grams (164 grams protein)	.295	.377	4.590
Eggs, 10,775 grams	10.775	1.616	39.544
Butter, 13,510 grams	2.972	.135	4.188
Cheese, 625 grams	7.750	.306	9.312
Milk, 55,725 grams	95.847	10.030	120.923
Cream, 18,305 grams	26.908	2.745	34.047
Barley, 365 grams	.091	.365	1.679
Flour and macaroni, 52,500 grams	14.700	13.650	113.400
Corn meal, 3,940 grams (new process)	.354	5.200	18.045
Oatmeal, 3,090 grams	2.410	7.694	30.096
Rice, 1,520 grams	.182	.912	.300
Bread, 5,105 grams	1.072	.909	8.270
Sugar, 23,250 grams	....	....	....
Molasses, 3,175 grams	11.271	5.588	4.191
Beans, Lima, dried, 1,275 grams	1.351	3.965	9.588
Beans, pea, dried, 3,035 grams	6.525	7.648	33.324
Cabbage, 1,930 grams	1.119	.405	1.563
Corn, canned, 1,825 grams	.821	1.277	4.690
Lettuce, 285 grams	.128	.034	.208
Onions, 535 grams	.214	.080	.428
Peas, canned, 5,175 grams	1.190	2.759	7.348
Potatoes, 35,855 grams	5.736	14.342	51.631
Potatoes, sweet, 3,795 grams	.948	.721	3.036
Tomatoes, canned, 6,045 grams	1.148	.967	2.720
Oranges, 2,440 grams	1.049	.390	1.171
Cranberries, 1,475 grams	.309	.177	.501
Prunellas (as prunes), 905 grams	.570	.760	1.846
In total food	201.739	98.122	688.339
In waste (7 per cent)	14.119	6.869	48.183
In total food eaten	187.620	91.253	640.156
Per man per day	.83	.40	2.82

DIETARY STUDY OF A TEACHER'S FAMILY IN INDIANA (NO. 44).[b]

This study was made in March, 1895, and continued 14 days. The family consisted of 4 men and 2 women. One of the men was a professor of mathematics, 1 an instructor in chemistry, the other 2 were college students. The younger woman was also a teacher. The total food consumed was equivalent to that of 1 man for 78 days. The

[a] U. S. Dept. Agr., Farmers' Bul. 142, p. 33.

[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 32, p. 12.

food eaten furnished 106 grams of protein and 2,780 calories, at a cost of 18 cents per man per day.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 44.

Food materials and weight of edible portion.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Beef, veal, pork, and lamb (total meat protein, 3,413 grams).	2.593	6.484	78.499
Eggs, 4,705 grams	4.705	.705	17.257
Butter, 1,785 grams	.392	.017	.543
Milk, 55,055 grams	94.694	9.909	119.469
Mince-meat, 370 grams	.162	.136	....
Corn meal, 2,395 grams	.215	3.161	10.969
Hominy, 255 grams (as old-process corn meal)	.033	.499	1.805
Flour and crackers, 14,625 grams	4.095	3.802	31.590
Oatmeal, 240 grams	.187	.597	2.337
Sugar, 6,605 grams	....	....	....
Maple sirup, 895 grams	1.100	.895	.895
Honey, 425 grams	.021	.127	.276
Beans, dried, 835 grams	1.795	2.104	9.168
Cabbage, 2,890 grams	1.676	.606	2.340
Corn, canned, 1,210 grams	.544	.847	3.109
Lettuce, 905 grams	.407	.108	.660
Parsnips, 795 grams	.604	.349	1.454
Potatoes, 6,750 grams	1.080	2.700	9.720
Radishes, 310 grams	.077	.058	.217
Apples, 5,470 grams	.601	.765	1.422
Bananas, 1,420 grams	.127	.497	.866
Cranberries, 355 grams	.074	.042	.120
Oranges, 540 grams	.232	.086	.259
Peaches, dried, 865 grams	.415	.804	2.889
Prunes, dried, 865 grams	277	.369	.897
Raisins, 45 grams	.018	.031	.108
In total food	116.124	35.698	296.879
In waste (4.3 per cent)	4.992	1.535	12.767
In food eaten	111.132	34.163	284.112
Per man per day	1.42	.44	3.64

DIETARY STUDY OF A SCHOOL SUPERINTENDENT'S FAMILY IN CHICAGO (NO. 91).[a]

This study was made in April and May, 1895, and covered 14 days. The family consisted of 1 man, 4 women (3 of whom were teachers), 2 children 8 and 2 years old, and occasional visitors. The total food consumed was equivalent to that of 1 man for 75 days. The food eaten per man per day furnished 123 grams protein and 3,260 calories, at a cost of 33.6 cents.

The table following shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 55, pp. 66, 67.

Estimated ash constituents in dietary study No. 91.

Food materials and weight of edible portion.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Beef, veal, lamb, and chicken (total meat protein, 4,275 grams)	3.249	8.122	98.325
Fish, 2,040 grams (225 grams protein)	.405	.517	6.300
Eggs, 5,555 grams	5.555	.833	20.386
Butter, 4 320 grams	.950	.043	1.339
Cheese, 455 grams	5.642	.222	6.779
Milk, 25,400 grams	43.688	4.572	55.118
Cream, 3,175 grams	4.667	.476	5.905
Corn meal, 2,710 grams (new process)	.243	3.577	12.331
Flour, crackers, and macaroni, 16,785 grams	4.700	4.364	36.255
Sugar, 4,535 grams	.....	.....	.....
Molasses, 225 grams	.798	.396	.297
Asparagus, 340 grams	.129	.057	.319
Beans, string, 1,130 grams	.824	.565	.102
Cucumbers, as purchased, 4,990 grams	1.397	.898	2.594
Lettuce, 455 grams	.204	.054	.332
Onions, 455 grams	.182	.068	.364
Peas, fresh, 1,475 grams	.516	.752	3.200
Potatoes, as purchased, 27,215 grams	4.354	10.886	39.189
Radishes, 455 grams	.113	.086	.318
Tomatoes, 1,820 grams	.345	.291	.419
Bananas, as purchased, 6,125 grams	.551	2.143	3.736
Lemons, as purchased, 2,040 grams	.877	.326	.979
Prunes, dried, 455 grams	.286	.382	.928
Strawberries, 4,080 grams	2.325	1.468	2.770
In total food	82.000	41.098	298.289
Per man per day (making no allowance for waste)	1.09	.55	3.97
Per man per day (allowing 10 per cent for waste)	.98	.50	3.58
Per man per day (allowing 5 per cent for waste)	1.04	.52	3.78

DIETARY STUDY OF A TEACHER'S FAMILY IN NEW YORK (NO. 485).[a]

This study began with breakfast December 8, 1905, and covered 10 days. The family consisted of 1 man, 3 women (1 of whom was a colored servant at active muscular work), and a child 16 months old. The total number of meals taken was estimated as equivalent to the food consumption of 1 man at teacher's occupation for 39 days. The food eaten furnished 102 grams of protein and 3,184 calories, at a cost of 29.4 cents per man per day.

The table following shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 185, p. 60.

Estimated ash constituents in dietary study No. 485.

Food materials and weight of edible portion.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Beef, 4,550 grams, pork and lard, 1,020 grams (total meat protein, 860 grams)	0.653	1.634	19.780
Codfish, 567 grams (protein, 95 grams)	.171	.213	2.660
Eggs, 2,920 grams	2.920	.438	10.716
Milk, 26,310 grams	45.253	4.738	57.092
Butter, 2,040 grams	.448	.020	.632
Cheese, 455 grams	5.642	.222	6.779
Bread, 7,120 grams, buns, 200 grams	1.537	1.390	11.858
Flour, 1,905 grams, crackers, 365 grams, macaroni, 135 grams	.673	.625	5.194
Ginger snaps, 270 grams, cookies, 90 grams	.144	.108	.900
Corn meal, 225 grams	.020	.297	1.030
Hominy, 113 grams	.015	.221	.800
Oatmeal, 905 grams	.705	2.253	8.814
Rice, 55 grams	.006	.033	.108
Sugar, 2,595 grams	....	....	....
Molasses, 410 grams	1.455	.721	.541
Beans, Lima, dried, 200 grams	.212	.622	1.504
Beans, pea, dried, 425 grams	.913	1.071	4.666
Beans, string, 965 grams	.704	.482	.878
Corn, sweet, dried, 115 grams	.182	.280	1.069
Lettuce, 255 grams	.114	.030	.186
Peas, dried, 90 grams	.123	.183	.769
Potatoes, 6,395 grams	1.023	2.558	9.208
Potatoes, sweet, 1,360 grams	.340	.258	1.088
Turnips, 1,725 grams	1.500	.500	1.845
Apples, fresh, 1,645 grams	.180	.230	.427
Apples, evaporated, 225 grams	.083	.121	.272
Bananas, 1,065 grams	.095	.372	.649
Grape jelly, 400 grams	.036	.060	.172
Orange, 75 grams	.032	.012	.136
Prunes, 565 grams	.355	.474	1.152
Raisins, 600 grams	.252	.420	1.440
Chocolate, 65 grams	.091	.313	.583
Olive oil, 70 grams	....	....	....
In total food eaten	65.878	20.918	152.848
Per man per day	1.69	.54	3.92

DIETARY STUDIES OF COLLEGE STUDENTS' CLUBS.

DIETARY STUDY OF A STUDENTS' CLUB, UNIVERSITY OF TENNESSEE (NO. 207).[a]

This study was made during 14 days in November, 1896, in a university boarding club. The group consisted of 90 men (2 professors, 87 students, and a servant), 9 women, of whom 5 were servants, and 1 child 10 years of age. The total food consumption was equivalent to that of 1 man for 1,278 days. The food eaten per man per day furnished 123 grams protein and 3,595 calories, at a cost of 18 cents.

The table following shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 53, p. 19.

Estimated ash constituents in dietary study No. 207.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, veal, pork, fowl (total meat protein, 81 kilograms)	61.5	153.9	1,863.0
Fish: Cat fish, salmon (total fish protein, 6.6 kilograms)	11.8	15.1	184.8
Eggs, 56.05 kilograms	56.0	8.4	....
Butter, 75.64 kilograms	16.6	.7	23.4
Milk, 636 kilograms	1,094.1	114.4	1,380.1
Corn meal, 42.4 kilograms	3.8	55.9	194.6
Corn meal, grits and hominy (as old-process meal), 10.9 kilograms	1.5	21.3	77.1
Oatmeal, 42.9 kilograms	33.4	106.8	417.8
Graham flour, 6.9 kilograms	2.5	10.3	45.5
Flour and crackers, 189.3 kilograms	53.0	49.2	408.8
Rice, 10.7 kilograms	1.2	6.4	21.1
Bread, 50.2 kilograms	10.5	9.5	81.3
Chocolate, 1.47 kilograms	2.0	7.1	13.1
Sugar, 164.4 kilograms	....	....	....
Molasses, 36.3 kilograms	128.8	63.8	47.9
Cornstarch and tapioca, 4.8 kilograms	....	....	....
Beans, dried, 6.35 kilograms	13.6	16.0	69.7
Cabbage, 25.3 kilograms	14.6	5.3	20.4
Celery, 0.905 kilogram	.8	.2	.9
Lettuce, 11.7 kilograms	5.2	1.4	8.5
Potatoes, 134.3 kilograms	21.4	53.7	193.3
Sweet potatoes, 87.2 kilograms	21.8	16.5	69.7
Turnips, 24.5 kilograms	21.3	7.1	26.2
Tomatoes, canned, 36.9 kilograms	7.0	5.9	16.6
Corn, canned, 8.6 kilograms	3.8	6.0	22.1
Pickles and chowder, 29 kilograms	8.1	5.2	15.0
Apples, 98.5 kilograms	10.8	13.7	25.6
Cranberries, 4.8 kilograms	1.0	.5	1.6
Bananas, 5.1 kilograms	.4	1.7	3.1
Currants, dried, 0.68 kilogram	1.1	.5	1.2
Figs, 5.5 kilograms	15.4	7.9	18.2
Grapes, 18.4 kilograms	2.5	3.4	11.9
Peaches and pears, canned, 24.8 kilograms	2.2	2.3	6.4
Apricots, peaches, and pears, evaporated, 10.03 kilograms	80.8	85.5	275.5
Oranges, 1.02 kilograms	.4	.1	.4
Prunes, dried, 7.37 kilograms	4.6	6.2	15.0
In total food purchased	1,713.5	861.9	5,559.8
In waste (7 per cent)	119.9	60.3	389.1
In total food eaten	1,593.6	801.6	5,170.7
Per man per day	1.25	.63	4.05

DIETARY STUDY OF WOMEN STUDENTS, PAINESVILLE, OHIO (NO. 323).[a]

This study covered 10 days of January, 1900. The group studied consisted of 115 women, of whom 20 were instructors, 91 students, and 4 servants. The total meals taken were equivalent to the food of 1 woman for 1,049 days. "The attempt was made to regulate the diet in such a way that it should not exceed a definite cost and at the same time please the students." The food eaten per woman per day furnished on an average 68 grams protein and 2,665 calories, at a cost of 18.3 cents.

The table following shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] For full data regarding the amount and composition of the food eaten, see U. S. Dept. Agr., Office Expt. Stas. Bul. 91, p. 30.

Estimated ash constituents in dietary study No. 323.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, mutton, pork, chicken (total meat protein, 33.6 kilograms)	25.5	63.8	772.8
Fish and oysters (protein 1.06 kilograms)	1.9	2.4	29.6
Eggs, 13 kilograms	13.0	1.9	47.7
Butter, 60.5 kilograms	13.3	.6	18.7
Cheese, 5.78 kilograms	71.6	2.8	8.6
Milk, 322.7 kilograms	554.0	58.0	700.2
Cream, 5.45 kilograms	8.0	.8	10.1
Corn meal, 11.8 kilograms	1.0	15.5	54.0
Hominy, 2.7 kilograms	.3	5.2	19.1
Wheat breakfast food (as Graham flour) 15.1 kilograms	5.5	22.6	99.6
Graham flour, 33.7 kilograms	12.4	50.5	222.2
Rice, 7 kilograms	.8	4.2	13.8
Whole wheat flour, 3.27 kilograms	1.2	4.9	21.5
Flour and crackers, 142 kilograms	39.7	36.9	306.7
Sugar, 74.9 kilograms			
Cornstarch, 0.8 kilogram			
Tapioca, 1.8 kilograms			
Molasses, 6.6 kilograms	23.4	11.6	8.7
Maple sirup, 7.9 kilograms	9.7	7.9	7.9
Chocolate, 1.1 kilograms	1.5	5.3	9.8
Beans, Lima, dried, 4.9 kilograms	5.1	15.2	36.8
Beans, pea, dried, 6.7 kilograms	14.4	16.8	73.5
Beets, 14.1 kilograms	2.6	4.0	13.3
Cabbage, 4.5 kilograms	2.6	.9	3.6
Parsnips, 15.9 kilograms	12.0	6.9	29.0
Peas, canned, 10.3 kilograms	2.3	3.5	15.6
Peas, dried, 2 kilograms	2.7	4.0	17.1
Potatoes, 139 kilograms	22.2	55.6	61.1
Sweet potatoes, 16.6 kilograms	4.1	3.1	13.2
Spinach, 5.14 kilograms	3.2	2.7	5.2
Squash, 5.14 kilograms	5.3	2.3	22.6
Tomatoes, 11.1 kilograms	2.1	1.7	4.9
Turnips, 14.5 kilograms	13.6	4.2	15.5
Cucumbers, pickles, 4.3 kilograms	1.2	.7	2.2
Apples, 44.3 kilograms	4.8	6.2	11.5
Apricots, 5.2 kilograms	1.0	.9	3.0
Apple butter, 13.8 kilograms	1.5	1.9	3.5
Bananas, 30 kilograms	2.7	10.5	18.3
Cherries, canned 4.5 kilograms	.7	.8	2.2
Cranberry sauce, 11.8 kilograms	1.6	.9	2.7
Dates, 8.8 kilograms	9.1	193.1	10.7
Figs, 1.4 kilograms	3.9	2.0	4.6
Lemons, 2.7 kilograms	1.1	.4	1.2
Oranges, 68.2 kilograms	29.3	10.9	32.7
Prunes, 4.9 kilograms	3.0	4.1	9.9
Raisins, 0.7 kilogram	.2	.4	1.6
Raspberry jam, 6.4 kilograms	3.0	1.6	3.9
In total food	938.1	650.2	2,780.4
In waste (13 per cent)	121.9	84.5	361.4
In total food eaten	816.2	565.7	2,419.0
Per woman per day	.78	.54	2.30
Estimated per man per day	.97	.67	2.88

DIETARY STUDIES OF MECHANICS' AND INDOOR LABORERS' FAMILIES.

DIETARY STUDY OF A CARPET DYER'S FAMILY IN NEW YORK (NO. 35).[a]

This study was made in April and May, 1895, and covered 10 days. The group consisted of the family and 3 boarders, and included 4 men, 1 woman, 3 boys (aged 12, 7, and 3 years), and 6 girls (aged 14, 11, 6, 4, and 2 years, and 8 months). The woman did sewing, and the 14-year-old girl did the marketing and housekeeping. The total meals taken were equivalent to the meals of 1 man for 92 days. The food eaten

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 46, pp. 23, 78.

cost 16 cents and furnished 71 grams of protein and 2,430 calories per man per day.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 35.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, pork, and chicken (total meat protein, 2,685 grams)	2.040	5.101	61.755
Fish: Cod, salmon, and sardines (total fish protein, 400 grams)	.720	.920	11.200
Eggs, 3,445 grams	3.445	.516	12.643
Butter, 3,530 grams	.798	.036	1.125
Cheese, 410 grams	5.084	.200	6.109
Milk, 11,725 grams	20.167	2.110	25.443
Condensed milk, 455 grams	1.956	.204	2.466
Barley (pearled), 680 grams	.170	.680	3.128
Flour, crackers, and macaroni, 2,635 grams	.737	.685	5.691
Oatmeal, 1,360 grams	1.060	3.386	13.264
Bread, 23,845 grams	5.007	4.530	38.628
Rice, 410 grams	.049	.246	.811
Sugar, 6,850 grams, tapioca, 455 grams			
Cabbage sprouts, 1,770 grams	1.416	.531	1.504
Onions, 2,765 grams	1.106	.414	2.212
Potatoes, 15,865 grams	2.538	6.346	22.845
Soup greens, 170 grams	.136	.051	.144
Jam, 575 grams	.080	.069	.143
Plums, canned, 225 grams	.031	.027	.056
Prunes, dried, 680 grams	.428	.571	1.387
Raisins, 455 grams	.191	.318	1.092
In total food	47.160	26.941	211.626
In waste (1.2 per cent)	.565	.323	2.539
In total food eaten	46.595	26.618	209.087
Per man per day	.501	.289	2.273

DIETARY STUDY OF A TIN ROOFER'S FAMILY IN NEW YORK CITY (NO. 112).[a]

This study was made during 11 days in November, 1895. The group comprised the family proper and 3 boarders. It was considered a typical Irish-American family. Five men and 4 women were included in the study, the son and daughters being grown. The total meals taken were equivalent to the meals of 1 man for 93 days. The food purchased, which was all eaten, furnished per man per day 84 grams of protein and 2,335 calories, at a cost of 16 cents.

The table following shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 46, pp. 59, 109.

Estimated ash constituents in dietary study No. 112.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef and pork (total meat protein, 4,170 grams)	3.169	7.923	95.910
Fish: Fresh and salt cod (total fish protein, 205 grams)	.369	.471	5.740
Eggs, 3,285 grams	3.285	.492	12.055
Butter, 3,200 grams	.704	.032	.992
Milk, 14,235 grams	24.484	2.562	30.889
Oatmeal, 905 grams	.705	2.253	8.814
Rice, 230 grams	.027	.138	.455
Bread, 17,500 grams	3.675	3.325	28.350
Sugar, 5,615 grams	.....	.....	.....
Cabbage, 7,175 grams	3.161	1.506	5.811
Corn, canned, 910 grams	.409	.637	2.338
Onions, 905 grams	.362	.135	.724
Peas, canned, 905 grams	.208	.307	1.285
Potatoes, 21,800 grams	3.488	8.720	31.392
In total food eaten	44.046	28.501	224.755
Per man per day	.47	.30	2.41

DIETARY STUDY OF A SEWING WOMAN'S FAMILY IN NEW YORK CITY (NO. 48).[a]

This study was made during 7 days of June, 1895. The family consisted of the mother, 5 sons aged 14, 11, 8, 4, and 3 years, and 1 daughter, 6 years old. The total food consumption was equivalent to that of 1 man for 28 days. The income of the family was only $30 to $40 a month, of which $10 was paid for rent. As the mother was the principal wage-earner, it was impossible to give much time to the purchasing and preparation of the food. The cost per person per day was less than 6 cents, calculated per man per day, 9 cents. The food eaten furnished per man per day 54 grams of protein and 1,500 calories.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 48.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef and pork (total meat protein, 170 grams)	0.129	0.323	3.910
Fish: Sardines (protein, 58 grams)	.104	.133	1.624
Eggs, 1,625 grams	1.625	.243	5.963
Butter, 225 grams	.049	.002	.069
Milk, 8,390 grams	14.430	1.510	18.206
Barley (pearled), 340 grams	.085	.340	1.564
Bread, rolls, and cake, 3,685 grams	.773	.700	5.969
Flour and crackers, 1,815 grams	.508	.471	3.920
Sugar, 1,735 grams	.....	.....	.....
Beans, dried, 905 grams	1.945	2.280	9.936
Potatoes, 1,815 grams	.290	.726	2.613
Radishes, 285 grams	.071	.054	.199
Rhubarb, 180 grams	.108	.018	.185
Tomatoes, canned, 1,135 grams	.215	.181	.510
In total food purchased	20.336	6.981	54.668
In waste (6 per cent)	1.220	.418	3.280
In total food eaten	19.116	6.563	51.388
Per man per day	.682	.234	1.835

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 46, pp. 33, 86.

DIETARY STUDY OF A HOUSE DECORATOR'S FAMILY IN PITTSBURG (NO. 190).[a]

This study was made during 30 days in January and February, 1897, in a family consisting of 1 man, 1 woman, a girl of 15, and 2 boys, 12 and 2 years old. The meals taken were estimated as equivalent to those of 1 man for 96 days. The income was estimated as $84 per month, and as the result of good management in the marketing a considerable variety of both animal and vegetable foods was obtained. The food eaten furnished per man per day 112 grams of protein and 3,305 calories, at a cost of 19.6 cents.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 190.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, veal, lamb, pork (total meat protein, 5,495 grams)	4.176	10.440	126.385
Oysters (protein, 36 grams)	.064	.082	1.008
Eggs, 1,875 grams	1.875	.281	6.881
Butter, 2,995 grams	.638	.029	.928
Milk, 32,590 grams	56.054	5.866	70.720
Barley (pearled), 285 grams	.071	.285	1.311
Corn meal, 940 grams	.084	1.240	4.305
Flour and crackers, 19,680 grams	5.510	5.116	42.508
Rice, 255 grams	.030	.153	.504
Bread and cake, 5,345 grams	1.101	.996	8.496
Beans, dried, 1,375 grams	2.956	3.455	15.097
Beets, 3,090 grams	.587	.896	2.935
Cabbage, 5,895 grams	3.419	1.237	4.774
Corn, canned, 1,770 grams	.079	1.239	4.548
Onions, 200 grams	.080	.030	.160
Peas, canned, 595 grams	.136	.202	.844
Pickles, 765 grams (as cucumbers)	.214	.137	.397
Potatoes, sweet, 4,155 grams	1.038	.789	3.324
Potatoes, 21,625 grams	3.460	8.650	31.140
Soup greens, 15 grams	.012	.004	.012
Turnips, 2,905 grams	2.527	.842	3.108
Catsup, 300 grams (as tomato)	.057	.048	.135
Chili sauce, 965 grams (as tomato)	.183	.154	.484
Sauerkraut, 1,335 grams (as cabbage)	.774	.280	1.081
Apples, 22,985 grams	2.528	3.217	5.976
Bananas, 2,730 grams	.245	.955	1.655
Oranges, 1,010 grams	.434	.161	.484
Lemons, 260 grams	.111	.041	.124
Peaches, canned, 1,940 grams	.194	.232	.620
Plum butter, 3,315 grams (as plums)	.729	.629	1.259
In total food	89.386	47.696	341.153
In waste (3.2 per cent)	2.860	1.526	10.916
In food eaten	86.526	46.170	330.237
Per man per day	.901	.480	3.439

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 52, p. 31.

DIETARY STUDY OF A GLASS BLOWER'S FAMILY IN PITTSBURG (NO. 191).[a]

This study was made in a family of adults, 4 men and 3 women, in January and February, 1897, and covered 31 days, during which the total number of meals taken was equivalent to the meals of 1 man for 186 days. Two of the men were idle at the time of the study. The food eaten furnished per man per day 94 grams of protein and 3,085 calories, at a cost of 16 cents.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 191.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, veal, lamb, pork, chicken (total meat protein, 8,537 grams)	6.488	16.220	196.351
Fish (protein, 287 grams)	.516	.660	8.036
Eggs, 3,995 grams	3.995	.590	14.661
Butter, 6,675 grams	41.047	4.295	51.787
Cottage cheese, 2,520 grams	2.520	.378	11.466
Corn meal, 1,375 grams	.123	1.815	6.297
Flour and crackers, 40,960 grams	11.468	10.649	88.473
Oatmeal, 880 grams	.686	2.191	8.571
Rice, 555 grams	.066	.333	1.098
Bread and cake, 9,765 grams	2.050	1.855	15.819
Sugar, 18,345 grams, cornstarch, 40 grams			
Beans, dried, Lima, 1,300 grams	1.378	4.043	9.776
Corn, canned, 625 grams	.281	.437	1.606
Celery, 325 grams	.305	.087	.325
Onions, 2,255 grams	.902	.338	1.804
Potatoes, 34,350 grams	5.496	13.740	40.494
Potatoes, sweet, 2,995 grams	.748	.569	2.396
Tomatoes, canned, 3,835 grams	.728	.613	1.725
Turnips, 4,335 grams	3.771	1.257	4.638
Catsup, 2,710 grams (as tomatoes)	.514	.433	1.219
Pickles, 425 grams (as cucumbers)	.119	.076	.221
Sauerkraut, 2,780 grams (as cabbage)	1.612	.583	2.251
Vegetable soup, 3,855 grams	1.002	.809	21.281
Apples, 18,780 grams	2.065	2.629	4.882
Bananas, 780 grams	.070	.273	.475
Figs, dried, 610 grams	1.708	.878	2.025
Lemons, 60 grams	.025	.009	.028
Peaches, dried, 225 grams	.108	.209	.751
Jelly and jam, 1,785 grams	.240	.214	.446
Apples, fresh, and tomato butter, 2,355 grams	.259	.329	.672
In total food	91.767	66.587	510.613
In waste (0.7 per cent)	.642	.466	3.574
In food eaten	91.125	66.121	507.039
Per man per day	.489	.355	2.726

DIETARY STUDY OF A MILL WORKMAN'S FAMILY IN PITTSBURG (NO. 128).[b]

This study was made during 29 days of January and February, 1896, in a family consisting of 2 men, 1 woman, 2 girls aged 16 and 6, and 3 boys aged 13, 10, and 8 years, respectively, the total food eaten being equivalent to the meals of 1 man for 167 days. This

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 52, p. 35.

[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 52, p. 18.

family was taken as representative of a large class of poor foreign laborers in Pittsburg. The food eaten, calculated per man per day, cost 13 cents, and furnished 83 grams of protein and 2,525 calories.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 128.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef and pork (total meat protein, 5,685 grams)	4.320	10.821	130.755
Fish: Herring and salmon (total fish protein, 708 grams)	1.274	1.628	19.824
Eggs, 2,735 grams	2.735	.410	10.037
Butter, 5,480 grams	1.205	.054	1.698
Cheese, 740 grams	9.176	.362	11.026
Milk, 19,305 grams	33.204	3.474	41.891
Barley, 255 grams	.063	.255	1.173
Flour, 2,555 grams	.715	.664	5.518
Oatmeal, 455 grams	.334	1.132	4.431
Rice, 455 grams	.054	.273	.900
Bread and cake, 46,960 grams	9.861	8.942	76.075
Pie, mince, 2,585 grams	1.137	.956	4.937
Sugar, 8,210 grams			
Molasses, 1,755 grams	6.230	3.088	2.316
Beans, dried, 2,350 grams	5.052	5.922	25.803
Peas, dried, 115 grams	.157	.234	.983
Onions, 1,205 grams	.482	.180	.964
Potatoes, 48,335 grams	7.733	19.334	69.602
Tomatoes, canned and catsup, 1,835 grams	.348	.293	.825
Apples, 1,020 grams	.112	.142	.265
Jam, 570 grams	.079	.068	.142
Prunes, 400 grams	.252	.336	.816
In total food	84.543	58.568	409.981
In waste (1.8 per cent)	1.522	1.054	8.380
In food eaten	83.021	57.514	401.601
Per man per day	.50	.34	2.40

DIETARY STUDY OF A MILL WORKMAN'S FAMILY IN PITTSBURG (NO. 129).[a]

This study was begun in January, 1896, and continued 29 days. The family consisted of 2 men, 2 women, and 5 children, aged, respectively, 13, 10, 7, and 4 years, and 7 months. The family was in very poor circumstances. The total number of meals taken was calculated by the usual factors as equivalent to the meals of 1 man for 174 days. The food furnished per man per day 77 grams protein and 2,440 calories, at a cost of 8.7 cents.

The table following shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 52, p. 22.

Estimated ash constituents in dietary study No. 129.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef and pork (total meat protein, 5,350 grams)	4.066	10.165	123.060
Oysters (protein, 32 grams)	.057	.073	.896
Butterine, 3,910 grams (as butter)	.860	.039	1.212
Cheese, 4,860 grams	23.064	.911	27.714
Milk, 14,745 grams	25.361	2.654	31.996
Flour, 9,810 grams	2.746	2.550	20.189
Oatmeal, 285 grams	.222	.709	2.775
Bread, cake, and rolls, 52,075 grams	....	....	....
Pie, 3,720 grams	....	....	....
Sugar, 10,455 grams	....	....	....
Beans, dried, 580 grams	1.247	1.461	6.308
Beans, dried, Lima, 1,330 grams	1.409	4.136	10.001
Cabbage, 4,500 grams	2,662	.963	3.717
Carrots, 670 grams	.515	.214	.620
Celery, 200 grams	.188	.054	.310
Onions, 3,445 grams	1.378	.516	2.756
Parsnips, 655 grams	.497	.288	1.196
Potatoes, 21,215 grams	3.394	8.086	30.549
Watercress, 115 grams	.297	.052	.073
Ruta-bagas, 2,180 grams	1.264	.457	1.765
Apples, 1,715 grams	.188	.240	.445
Apple jelly, 365 grams	.025	.032	.062
In total food	69.440	33.600	265.597
In waste (0.6 per cent)	.416	.201	1.593
In food eaten	69.024	33.399	264.004
Per man per day	.396	.192	1.517

DIETARY STUDY OF A MECHANIC'S FAMILY IN KNOXVILLE, TENN. (NO. 181).[a]

The family here studied consisted of 1 man, 2 women, and a boy 11 years old. The man was an engineer at hard work. The study covered 14 days in February, 1896. The total number of meals taken was equivalent to the food of 1 man for 48 days. The food eaten furnished per man per day 97 grams of protein and 4,060 calories, at a cost of 12 cents.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 181.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Pork and chicken (total meat protein, 1,380 grams)	1.048	2.622	31.740
Butter, 1,590 grams	.349	.015	.492
Buttermilk (as milk), 9,070 grams	15.600	1.632	19.681
Eggs, 1,135 grams	1.135	.170	4.165
Corn meal, 14,720 grams	1.324	19.430	67.417
Flour, 9,410 grams	2.634	2.446	20.325
Sugar, 455 grams	....	....	....
Beans, dried, 1,815 grams	3.902	4.673	19.928
Peas, dried, 905 grams	1.239	1.846	7.737
Onions, 680 grams	.272	.102	.544
Turnip greens, 3,630 grams	18.440	1.306	3.557
Potatoes, 8,255 grams	1.320	3.302	11.887
Fruit jelly, 1,700 grams	.153	.255	.731
In total food	47.416	37.790	188.204
In waste (8.6 per cent)	4.077	3.250	16.185
In food eaten	43.339	34.549	172.019
Per man per day	.902	.719	3.581

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 53, p. 15.

DIETARY STUDIES OF FARMERS' FAMILIES AND OUTDOOR LABORERS.

DIETARY STUDY OF MAINE LUMBERMEN (NO. 391).[a]

This study was begun in January, 1902, and continued 16 days. The group included 30 men, most of whom were engaged in severe outdoor labor. The total number of meals taken was equivalent to the meals of 1 man for 492 days. The food eaten furnished per man per day 179 grams of protein and 6,780 calories, at a cost of 23.6 cents.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 391.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, pork, and sausage (total meat protein, 35.2 kilograms)	26.752	66.880	809.610
Fish: Cod, mackerel, and salmon (total fish protein, 9 kilograms)	16.200	20.700	252.000
Butter, 20.9 kilograms	4.598	.209	6.479
Condensed milk, 1.4 kilograms	6.020	.630	7.588
Lard compound, 64.8 kilograms	.....	.....	.....
Corn meal, 5.7 kilograms	.513	7.524	26.106
Oatmeal, 0.9 kilogram	.702	2.241	8.766
Rice, 3.6 kilograms	.432	2.160	7.128
Flour, 173.6 kilograms	48.608	45.136	374.976
Sugar, 63 kilograms	.....	.....	.....
Molasses, 68.2 kilograms	242.110	120.032	90.024
Beans, dried, 101.6 kilograms	218.440	256.032	1,115.568
Carrots, 5.5 kilograms	4.235	1.760	5.170
Peas, dried, 4.5 kilograms	6.165	9.180	38.475
Potatoes, 78 kilograms	12.480	31.200	112.320
Onions, 0.2 kilogram	.080	.030	.160
Turnips, 28.6 kilograms	24.882	8.294	30.602
Apples, dried, 18.4 kilograms	6.808	9.936	22.264
Prunes, 28 kilograms	17.640	23.520	57.120
Raisins, 4.5 kilograms	1.890	3.150	10.800
Currant jelly, 7.5 kilograms	2.400	1.275	3.525
Strawberry jelly, 8.4 kilograms	3.192	2.016	3.780
In total food	644.147	611.905	2,982.461
In waste (3 per cent)	19.324	18.357	89.473
In food eaten	624.823	593.548	2,892.988
Per man per day	1.269	1.206	5.880

DIETARY STUDY OF A FARMER'S FAMILY IN CONNECTICUT (NO. 45).[b]

This study was made in December, 1894, and continued 7 days. The family consisted of 2 men, 1 woman, a boy 7 years old, a girl 4 years old, and a child under 2 years. The total number of meals taken was equivalent to the meals of 1 man for 27 days. The food furnished 108 grams protein and 3,548 calories per man per day.

The table following shows the kinds and amounts of food used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 149, p. 17.

[b] Connecticut Storrs Sta. Rpt. 1895, p. 148.

Estimated ash constituents in dietary study No. 45.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, lard, and chicken (protein, 671 grams)	0.509	1.274	15.433
Milk, 9,000 grams	15.480	1.620	19.530
Butter, 455 grams	.100	.004	.141
Flour, 12,700 grams	3.556	3.302	27.432
Sugar, 2,040 grams	.....	.....	.....
Cabbage, 3,630 grams	2.105	.762	2.940
Potatoes, 8,095 grams	1.295	3.238	11.656
Pumpkins, 4,535 grams	1.451	.634	6.122
Squash, 680 grams	.217	.095	.918
Sweet potatoes, 3,175 grams	.793	.603	2.540
Turnips, 4,765 grams	4.145	1.381	5.098
Apples, 13,260 grams	1.458	1.856	3.447
In total food eaten	31.109	14.769	95.257
Per man per day	1.152	.547	3.528

DIETARY STUDY OF A FARMER AND MECHANIC'S FAMILY IN TENNESSEE (NO. 182).[a]

This study was made during 14 days in March, 1896, in a family consisting of 3 men and 3 women, the total meals taken being equivalent to the meals of 1 man for 66 days. The food eaten furnished 95 grams of protein and 2,820 calories at a cost of 19 cents per man per day.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 182.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams*
Meat: Beef and pork (total meat protein, 2,250 grams)	1.710	4.275	51.750
Fish (protein, 279 grams)	.502	.641	7.812
Eggs, 5,605 grams	5.605	.840	20.600
Butter, 1,980 grams	.435	.019	.613
Milk and buttermilk, 16,950 grams	29.154	3.051	36.781
Flour and crackers, 10,525 grams	2.947	2.736	22.734
Oatmeal, 2,435 grams	1.899	6.063	23.716
Rice, 565 grams	.067	.339	1.118
Sugar, 1,130 grams	.....	.....	.....
Maple sirup, 680 grams	.836	.680	.680
Tapioca, 115 grams	.....	.....	.....
Beans, dried, 3,705 grams	7.965	9.336	40.680
Cabbage, 1,360 grams	.788	.285	1.101
Corn, canned, 7,470 grams	3.361	5.229	19.197
Parsnips, 1,020 grams	.775	.448	1.866
Potatoes, 20,035 grams	3.205	8.014	28.850
Tomatoes, canned, 765 grams	.145	.122	.344
Raisins, 285 grams	.119	.199	.684
Canned huckleberries, 6,705 grams	1.609	1.206	3.084
In total food	61.122	43.483	261.610
In waste (10 per cent)	6.112	4.348	26.161
In food eaten	55.010	39.135	235.449
Per man per day	.83	.59	3.56

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 53, p. 16.

DIETARY STUDY OF FARM STUDENTS AT KNOXVILLE, TENN. (NO. 208).[a]

The group included in this study consisted of 13 men whose ages averaged 25.4 years, 5 women whose average age was 32 years, and 1 child 7 years old. The study covered 14 days in December, 1896, the total meals taken being equivalent to the meals of 1 man for 155 days. The rate of board was $2 per week. The food actually eaten per man per day furnished 66 grams of protein and 3,560 calories at a cost of 15 cents.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 208.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Beef, pork, lard, fowl (total meat protein, 2,470 grams)	1.877	4.693	56.810
Eggs, 1,995 grams	1.995	.299	7.321
Butter, 7,005 grams	1.541	.070	2.171
Milk and buttermilk, 26,820 grams	46.130	4.827	58.199
Corn meal, 2,720 grams	.244	3.590	12.457
Corn meal grits, 3,430 grams	.480	6.722	24.284
Flour and crackers, 46,490 grams	3.719	12.087	100.418
Oatmeal, 3,005 grams	2.343	7.482	29.268
Rice, 3,400 grams	.408	2.040	6.732
Bread and cake, 5,390 grams	1.131	1.024	8.731
Sugar, 12,930 grams	......	......	......
Molasses, 1,390 grams	4.934	2.446	1.834
Cabbage, 4,650 grams	2.697	.976	3.766
Celery, 1,135 grams	1.066	.306	1.135
Onions, 595 grams	.238	.089	.476
Sweet potatoes, 1,885 grams	.471	.358	1.508
Potatoes, 19,730 grams	3.156	7.892	28.411
Radishes, 340 grams	.085	.064	.238
Turnips, 3,175 grams	2.762	.920	3.397
Apples, 6,720 grams	.739	.940	1.747
Cranberries, 1,505 grams	.316	.180	.511
Canned grapes and blackberries, 4,085 grams	1.245	.775	2.001
Preserved plums, 5,870 grams	.821	.704	1.467
In total food	78.398	58.484	352.882
In waste (8.6 per cent)	6.742	5.029	30.348
In food eaten	71.656	53.455	322.534
Per man per day	.46	.34	2.08

DIETARY STUDY OF A NEGRO FARMER'S FAMILY IN ALABAMA (NO. 139).[b]

This family consisted of 1 man and 1 woman. The study was begun in January, 1896, and continued 16 days. The food taken was estimated to be equivalent to the meals of 1 man 29 days. The man and wife lived in a one-room cabin and worked a 25-acre farm, which was part of a large plantation about 7 miles from Tuskegee. They were in more comfortable circumstances than most negro farmers of the region. They expended for food about 10 cents per day

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 53, p. 21.
[b] U. S. Dept. Agr., Office Expt. Stas. Bul. 38, p. 56.

and obtained (on the same basis) 80 grams of protein and 4,955 calories.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole:

Estimated ash constituents in dietary study No. 139.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Pork, bacon, and lard (total meat protein, 683 grams)	0.519	1.297	15.709
Milk, 1,020 grams	1.754	.183	2.213
Corn meal, 13,610 grams	1.224	17.965	62.333
Flour, 5,245 grams	1.468	1.363	11.329
Rice, 595 grams	.714	.357	1.178
Sugar, 1,030 grams	.....	.....	.....
Sweet potatoes, 1,985 grams	.496	.377	1.568
In total food	6.175	21.542	94.350
Per man per day	.213	.742	3.253

DIETARY STUDY OF A NEGRO FARMER'S FAMILY IN ALABAMA (NO. 100).[a]

This study was made at the same time and in the same region as the one preceding. The family consisted of a man and wife and 5 children, the eldest of whom was 11 years old; total consumption of food being equivalent to the meals of 1 man 59 days. The food furnished 44 grams of protein and 2,240 calories at a cost of 3 cents per man per day.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole:

Estimated ash constituents in dietary study No. 100.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Bacon and lard (meat protein, 131 grams)	0.099	0.248	3.013
Flour, 9,470 grams	2.651	2.462	20.455
Corn meal, 20,920 grams	1.882	27.614	95.813
Rice, 710 grams	.085	.426	1.405
Collards, 255 grams (as cabbage)	.147	.053	.206
In total food eaten	4.864	30.803	120.892
Per man per day	.082	.522	2.049

If it be assumed that old-process corn meal was used, the estimated ash constituents would in this case be considerably higher.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 38, p. 28.

DIETARIES IN WHICH THE SOURCE OF PROTEIN WAS CONTROLLED.[a]

Dietaries No. 148 to 152 differ from the other 20 included in this study in that they were not simply observations upon freely chosen food. In 4 of these 5 dietaries attempts were made to influence the food supply, especially the foods which furnish the greater part of the protein. The following extract from the original description of these studies shows the questions which they were designed to solve and the general conditions under which observations were made:

It has been repeatedly demonstrated on the basis of chemical analyses and market prices that the edible dry matter of oysters, clams, poultry, and the choice cuts of beef has a market cost much greater than that of the edible dry matter from a forequarter of beef or from pork, milk, and cheese. Consequently the housewife and boarding-house steward are assured that there is opportunity of keeping down the cost of supplying the table by purchasing those materials which furnish a unit of nutrition for the least money, provided they can be prepared for the table in such palatable forms that they are relished, and eaten without excessive waste.

It is quite evident, however, that these conditions are more difficult in the concrete than in the abstract. The lack of culinary skill, the necessity for a desirable variety of foods, and the marked differences of individual tastes are all obstacles to the easy application of laboratory demonstrations to the management of a dietary.

It was felt that if these views of food economics could be made useful in practice it would be well worth while to show this by accurate experimental data. It was decided, therefore, that nothing could be undertaken more desirable from a practical standpoint than to attempt an application of the considerations above mentioned. * * *

The college boarding house [in which these studies were made] is connected with the dormitory and is patronized chiefly by the students living in the dormitory and the neighboring fraternity clubhouses. Certain members of the college faculty and a few outside students take their dinners at the boarding house regularly and others occasionally, thus making a larger number of dinners than of other meals. The regular student boarders were, with a single exception, all young men whose ages ranged from 17 to 23 years, and who weighed on an average about 150 pounds. They were all compelled to take a fair amount of physical exercise, due to enforced military drill and to afternoon practice work in the laboratories, and with engineering instruments in the field. It may be reasonably claimed that these young men performed a considerable amount of work. There were also several women boarders and employees who had meals regularly at the commons. * * * The general plan of the studies may be briefly outlined as follows: At the beginning of each dietary study a careful inventory by weight was taken of all the food and food materials in the house. During the experimental period all food purchased was weighed and recorded in the same way, and all table and kitchen waste carefully collected, weighed, and dried for subsequent analysis. * * *

In these dietary studies, as already stated, the attempt was made to deliberately control to some extent the source and supply of animal foods. The object of this control was to bring into comparison high-cost and low-cost foods as a source of protein, with especial attention to the influence of the free use of milk as a low-cost animal food upon the character and cost of the dietary.

---

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 37.

Milk was selected for special consideration for the following reasons: (1) Milk has a widespread use as an article of diet, and in all civilized countries is an important item of food supply. (2) Milk is a very valuable food. It contains a mixture of the three classes of nutrients in forms that are readily digested and assimilated. (3) Milk is a low-cost animal food in proportion to its value, as based upon chemical analysis. It is shown * * * that when milk is purchased at $2 per 100 pounds the cost of a pound of edible solids is 15.7 cents, while the cost of a pound of edible solids in beef at $10.50 per 100 pounds is 34.3 cents. This is a comparison of the retail cost of milk with the cost of hind-quarter beef when purchased by the carcass. Beef bought as steak at retail prices would have a much higher comparative cost. (4) Notwithstanding the high quality and very general distribution of milk as a food, it seems by many to be regarded as a luxury, in the purchase of which economy must be exercised. This attitude toward this particular food may in part be explained by the somewhat prevalent notion that a free supply of milk in the dietary is not economical, because it is supposed that as much of other foods is eaten as would be the case if milk were not taken. This belief runs contrary to certain generally accepted facts which relate to the physiological use of foods and it only remains for experimental data to prove or disprove its correctness. Again, milk is not given full credit by people at large for its true nutritive value. Surprise is generally occasioned by the statement that a quart of milk has approximately the food value of a pound of steak. It is important to demonstrate, for reasons of economy, whether, as is the custom with many, it is wise to purchase the least possible quantity of milk and exercise little care in buying meats.

To investigate these questions, five dietary studies were made. In the first no change was made from the ordinary condition of living; in the second the protein was derived chiefly from high-priced animal foods, and the supply of milk was limited; in the third protein was derived from cheaper sources and milk was very abundantly supplied; in the fourth and fifth no departure was made from the ordinary conditions except in the amount of milk supplied—in the fourth the milk supply being limited and in the fifth very abundant.

DIETARY UNDER ORDINARY CONDITIONS (NO. 148).[a]

The study began February 24, 1895, and continued 58 days. The total number of meals taken by men was 12,238 and by women 793. Total equivalent to 1 man for 4,344 days. The food eaten furnished per man per day 132 grams of protein and 4,990 calories at a cost of 26 cents

The table following shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 37, p. 26.

Estimated ash constituents in dietary study No. 148.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, veal, mutton, pork, poultry (total meat protein, 237.2 kilograms)	180.272	450.680	5,455.600
Fish: Cod, haddock, halibut, shad, clams, oysters (total fish protein, 43 kilograms)	77.400	98.900	1,204.000
Eggs, 229.5 kilograms	229.500	34.425	842.265
Butter, 225.8 kilograms	49.676	2.258	69.998
Milk, 3,953.1 kilograms	6,799.332	711.558	8,578.227
Gelatine, 1 kilogram	....	....	....
Corn meal, 65.5 kilograms	5.895	86.460	299.990
Hominy, 27.7 kilograms	3.878	46.813	196.116
Flour, crackers, macaroni, 1,802.8 kilograms	504.784	468.728	3,894.048
Graham flour, 30.8 kilograms	11.396	46.200	203.280
Oatmeal, 49.2 kilograms	38.376	122.508	479.208
Rice, 2.3 kilograms	.276	1.380	4.554
Brown bread, 407 kilograms	9.768	40.700	179.000
Cake, frosted, 2.3 kilograms	.483	.437	3.726
Cookies, 1.6 kilograms	.336	.304	2.692
Pie, cream, 1 kilogram	.300	.300	1.000
Pie, mince, 5 kilograms	2.200	1.850	9.550
Pie, squash, 22.2 kilograms	6.660	3.330	33.300
Cornstarch, 3.2 kilograms	....	....	....
Tapioca, 3.6 kilograms	....	....	....
Chocolate, 2.3 kilograms	3.243	11.109	20.631
Sugar, 1,093.6 kilograms	....	....	....
Molasses, 202.1 kilograms	717.455	355.696	266.772
Maple sirup, 321.4 kilograms	395.322	321.400	321.400
Beans, 104.8 kilograms	225.320	264.096	1,150.704
Beans, cooked, 9.5 kilograms	9.690	11.400	49.780
Beets, 11.6 kilograms	21.204	32.364	106.025
Cabbage, 112.5 kilograms	65.250	23.625	91.125
Carrots, 2.3 kilograms	1.771	.736	2.162
Onions, 37.2 kilograms	14.880	5.580	29.760
Parsnips, 22.1 kilograms	16.796	9.724	40.443
Peas, 4.5 kilograms	6.165	9.180	38.475
Peas, canned, 56 kilograms	12.880	19.040	79.520
Potatoes, 1,425.7 kilograms	228.112	570.280	2,053.008
Potatoes, cooked, 11.1 kilograms	2.131	5.328	19.179
Pumpkins, canned, 20.05 kilograms	6.416	2.807	27.067
Salad, 1.36 kilograms (as lettuce)	.612	.163	.992
Squash, 123.4 kilograms	39.488	27.276	166.690
Squash, canned, 23.7 kilograms	7.584	3.318	31.995
Tomatoes, canned, 24.5 kilograms	4.655	3.920	11.025
Turnips, 226.3 kilograms	196.881	65.627	242.141
Horse-radish, 10.7 kilograms	14.552	4.066	2.889
Catsup, 6 kilograms (as tomatoes)	1.140	.960	2.700
Cucumber pickles, 22.7 kilograms	6.356	4.106	11.804
Apples, evaporated, 10.4 kilograms	3.848	5.616	12.584
Apricots, dried, 6.8 kilograms	6.664	6.052	18.496
Crab apples, canned, 32.2 kilograms	.225	.289	.547
Blackberries, canned, 10.4 kilograms	5.408	2.392	5.720
Blueberries, canned, 26.2 kilograms	7.860	2.620	8.122
Currants, dried, 6.4 kilograms	10.816	4.864	11.392
Lemons, whole, 26 kilograms	11.180	4.160	12.480
Oranges, whole 45.4 kilograms	19.522	7.264	21.692
Pineapples, canned, 10 kilograms	2.500	1.800	1.400
Prunes, 11.3 kilograms	7.119	9.492	23.052
Prunes, cooked, 1.4 kilograms	.252	.336	.854
Raisins, 20.8 kilograms	8.736	14.560	49.920
In total food	10,002.565	3,928.077	26,289.100
In cooked food not eaten and in waste (23 per cent)	2,300.589	903.457	6,046.493
In food eaten	7,701.976	3,024.620	20,242.607
Per man per day	1.773	.696	4.659

DIETARY CONTAINING EXPENSIVE PROTEIN (NO. 149).[a]

In the second dietary study changes were made in the ordinary diet. Protein was supplied from expensive sources with a view to determining the effect on the amount and cost of the nutrients actually consumed. The matron was given the following instructions: Select animal food as far as possible from the following sources:

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 37, p. 30.

Hindquarter of beef, lamb, veal, chicken, eggs, halibut, salmon, shad, and lobster. During this period it is desirable that milk shall be served but once a day and that meat shall be used as freely as practicable, not only for dinner, but also for breakfast and supper. It is desired that meat shall be consumed in this period as freely as is consistent with health with a consequent diminishing of cereals and vegetable foods. Beans need not be served in this period unless in order to satisfy the boarders.

The study began April 24, 1895, and continued 26 days. Total meals taken by men, 4,011; by women, 310. Total equivalent to 1 man for 1,440 days.

The food eaten during this period furnished 112 grams of protein and 4,105 calories at a cost of 34 cents per man per day.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 149.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef, veal, mutton, pork, poultry (total meat protein, 95.1 kilograms)	72.276	180.690	2,187.300
Fish: Bluefish, cod, halibut, shad, lobster (total fish protein, 22.5 kilograms)	40.500	51.750	630.000
Eggs, 160.3 kilograms	160.300	24.045	588.301
Butter, 118.4 kilograms	26.049	1.184	36.704
Milk, 1,165.7 kilograms	2,005.004	209.826	2,529.659
Mincemeat, 46.7 kilograms	20.548	17.279	89.197
Corn meal, 23.6 kilograms	2.124	31.152	108.088
Hominy, 4.1 kilograms	.574	8.036	29.028
Flour, crackers, and macaroni, 330.6 kilograms	92.568	87.956	714.096
Graham flour, 7.3 kilograms	2.701	10.950	48.180
Oatmeal, 26.8 kilograms	20.904	67.732	261.032
Rice, 1.8 kilograms	.216	1.080	3.564
Bread and doughnuts, 20.1 kilograms	4.221	3.819	32.562
Cornstarch, 3.2 kilograms	....	....	....
Tapioca, 0.9 kilogram	....	....	....
Sugar, 226.8 kilograms	....	....	....
Molasses, 102.3 kilograms	363.165	179.848	135.036
Maple sirup, 25.6 kilograms	31.488	25.600	25.600
Beans, 31.7 kilograms	68.155	79.884	348.068
Beets, 67.1 kilograms	12.749	19.459	63.745
Carrots, 3.2 kilograms	2.464	1.024	3.008
Sweet corn, canned, 111.4 kilograms	50.130	77.980	296.298
Lettuce, 3.4 kilograms	1.530	.408	2.482
Parsnips, 45.4 kilograms	34.504	19.976	83.082
Peas, 6.4 kilograms	8.768	13.056	54.720
Peas, canned, 41.5 kilograms	9.545	14.110	58.930
Potatoes, 445.9 kilograms	71.394	178.360	642.006
Potatoes, cooked, 6.4 kilograms	1.229	3.070	11.059
Pumpkins, canned, 10 kilograms	3.200	1.400	1.350
Squash, 58 kilograms	1.856	.812	7.830
Squash, canned, 20.4 kilograms	6.523	2.856	27.540
Tomatoes, 46.7 kilograms	8.873	7.472	21.005
Catsup, 12.6 kilograms	2.394	2.016	5.670
Horse-radish, 8.4 kilograms	11.424	3.192	10.668
Apples, 10 kilograms	1.100	1.400	2.600
Apples, dried, 19 kilograms	7.030	10.260	22.990
Apricots, 22.7 kilograms	4.767	4.313	13.166
Bananas, 12.7 kilograms	1.143	4.445	7.747
Blackberries, canned, 10 kilograms	5.200	2.300	5.500
Blueberries, canned, 10 kilograms	3.000	1.000	3.100
Lemons, 6.8 kilograms	4.284	5.712	13.776
Prunes, 6.8 kilograms	4.284	5.712	13.872
Raisins, 4.5 kilograms	1.890	3.150	10.800
In total food	3,178.135	1,363.394	9,139.367
In cooked food not eaten and in waste (37 per cent)	1,175.909	504.455	3,381.565
In food eaten	2,002.226	858.939	5,757.802
Per man per day	1.390	.596	3.998

DIETARY CONTAINING CHEAP PROTEIN (NO. 150).[a]

The matron was given the following instructions: Select animal food so far as possible from the following sources: Forequarter of beef, fresh pork, ham, fresh cod, salt cod, and milk. During this period furnish milk as freely as it is called for, three times a day if possible. Furnish beans freely, twice a week regularly if practicable and whenever called for. Plan for such dishes as will require milk in cooking. Make a free use of bread. It is desired in this period to make the relative supply of meats smaller as compared with the bread and vegetables supplied than was the case in the second period.

The study began May 20, 1895, and continued 27 days. Meals eaten by men, 4,454; by women, 334. Total equivalent to 1 man for 1,596 days.

The food eaten furnished 112 grams of protein and 3,620 calories and cost 26 cents per man per day.

The table below shows the kind and amount of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 150.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meat: Beef and pork (total meat protein, 59.3 kilograms)	45.068	112.670	1,363.900
Fish: Cod and salmon (total fish protein, 25.9 kilograms)	46.620	59.570	725.200
Eggs, 83.9 kilograms	83.900	12.585	307.913
Butter, 116.6 kilograms	25.652	1.166	36.146
Milk, 1,909.6 kilograms	3,284.512	343.728	4,143.832
Corn meal, 33.1 kilograms	2.979	43.692	151.598
Hominy, 4 kilograms	.560	7.840	28.320
Flour and crackers, 457.5 kilograms	128.100	118.950	988.200
Graham flour, 20 kilograms	6.200	30.000	132.000
Oatmeal, 27.2 kilograms	21.216	67.728	264.928
Cake (as bread), 0.9 kilogram; cake, 6.1 kilograms	1.470	1.330	11.340
Cookies, molasses, 3.4 kilograms	1.360	1.020	8.500
Cookies, sugar, 4.7 kilograms	.987	.893	7.614
Pie, apple, 4.5 kilograms	1.350	1.350	4.500
Pie, cream, 2 kilograms	.800	.600	3.000
Pie, custard, 18.1 kilograms	10.860	5.430	36.200
Pie, mince, 5.9 kilograms	2.596	2.183	11.269
Pudding (as bread), 2.7 kilograms	.567	.513	4.374
Cornstarch, 3.2 kilograms			
Chocolate, 1.4 kilograms	1.974	6.762	12.558
Sugar, 248.8 kilograms			
Molasses, 77.3 kilograms	274.415	136.048	102.036
Maple sirup, 42.2 kilograms	51.906	42.200	42.200
Beans, 55.3 kilograms	118.895	139.356	607.194
Beets, 41.7 kilograms	7.923	12.098	39.615
Catsup (as tomatoes), 7.7 kilograms	1.463	1.232	3.465
Greens (dandelions), 14.9 kilograms	9.536	7.897	15.347
Horse-radish, 1.6 kilograms	2.176	.608	2.032
Onions, 4.5 kilograms	1.800	.675	3.600
Parsnips, 2.7 kilograms	2.052	1.188	4.941
Peas, canned, 15.7 kilograms	3.611	5.338	22.294
Potatoes, 433.6 kilograms	69.376	173.440	624.384
Pumpkins, canned, 14.1 kilograms	4.512	1.974	19.035
Rhubarb, 95.3 kilograms	57.180	9.530	98.159
Squash, canned, 10.9 kilograms	3.488	1.526	14.715
Tomatoes, canned, 37.2 kilograms	7.068	5.952	16.740
Turnips, 35.6 kilograms	30.972	10.324	38.092

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 38, p. 35.

Estimated ash constituents in dietary study No. 150—Continued.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Apples, evaporated, 15.9 kilograms	5.883	8.586	19.239
Apricot sauce, 10 kilograms	1.400	1.300	3.900
Bananas, whole, 10.9 kilograms	.981	3.815	6.649
Blueberries, canned, 20.6 kilograms	6.180	2.060	6.386
Lemons, whole, 101.2 kilograms	43.516	16.192	48.576
Pineapple, whole, 21.3 kilograms	8.094	5.751	4.686
Prunes, 6.8 kilograms	4.284	5.712	13.872
Prunes, cooked, 6 kilograms	1.080	1.440	2.660
Raisins, 2.3 kilograms	.966	1.610	5.520
In total food	4,385.528	1,413.857	10,007.729
In cooked food not eaten and in waste (30 per cent)	1,315.658	424.157	3,002.318
In food eaten	3,069.870	989.700	7,005.411
Per man per day	1.923	.620	4.389

DIETARY WITH LIMITED MILK SUPPLY (No. 151).[a]

In this dietary the meat and vegetable foods were selected as under ordinary conditions and the amount of milk furnished was reduced with a view to determining the effect of a limited milk supply on the amount and cost of the nutrients actually consumed. The study began September 2, 1895, and continued 49 days. Meals taken by men, 10,071; by women, 470. Total equivalent to 1 man for 3,514 days. The food eaten contained 131 grams of protein and 4,595 calories and cost 27 cents per day.

The table below shows the kind and amount of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

Estimated ash constituents in dietary study No. 151.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Beef, veal, mutton, pork, poultry (total meat protein, 179.3 kilograms)	136.268	340.670	4,123.900
Fish: Bluefish, cod, halibut, oysters (total fish protein, 24.2 kilograms)	43.560	55.660	677.600
Eggs, 169.4 kilograms	169.400	25.410	621.698
Butter, 235.4 kilograms	51.788	2.354	72.974
Milk, 3,064.1 kilograms	5,280.252	551.538	6,649.097
Cream, 2.3 kilograms	3.381	.345	4.278
Chocolate, 2.7 kilograms	3.807	13.041	24.219
Corn meal, 34 kilograms	3.060	44.880	155.720
Cornstarch, 3.6 kilograms	....	....	....
Flour, crackers, and macaroni, 1,313.5 kilograms	367.780	341.510	2,837.160
Graham flour, 20.4 kilograms	7.548	30.600	134.640
Hominy, 4.1 kilograms	.574	8.036	29.002
Maple sirup, 15 kilograms	18.450	15.000	15.000
Molasses, 29.9 kilograms	106.145	52.724	39.468
Oatmeal, 106.6 kilograms	83.148	265.434	1,038.284
Rice, 4.5 kilograms	.540	2.700	8.910
Sugar, 557.5 kilograms	....	....	....
Tapioca, 3.2 kilograms	....	....	....
Beans, yellow-eyed, 50.8 kilograms	114.808	132.588	627.380

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 37, p. 40.

227

Estimated ash constituents in dietary study No. 151—Continued.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Beans, white, 39.5 kilograms	84.925	99.540	433.710
Beets, 25.9 kilograms	4.921	7.511	24.605
Cabbage, 117.9 kilograms	68.382	24.759	95.499
Carrots, 3.6 kilograms	2.772	1.152	3.384
Cucumbers, 15.9 kilograms	4.452	2.862	8.268
Onions, 17.2 kilograms	6.880	2.580	13.760
Potatoes, 1,481 kilograms	236.960	592.400	2,132.640
Sweet potatoes, 247.2 kilograms	61.800	46.968	197.760
Pumpkin, canned, 15.9 kilograms	5.088	2.226	21.465
Squash, canned, 1.4 kilograms	.448	.196	1.890
Squash, 10.4 kilograms	3.328	1.456	1.404
Sweet corn, fresh, 18.1 kilograms	8.145	12.670	46.517
Sweet corn, canned, 27.4 kilograms	12.330	19.180	70.418
Tomatoes, 190.3 kilograms	36.157	30.448	85.635
Turnips, 47.6 kilograms	41.412	13.805	50.932
Cucumber pickles, 22.2 kilograms	6.216	3.996	11.544
Horse-radish, evaporated, 0.18 kilogram	.244	.068	.228
Horse-radish, fresh, 2.95 kilograms	4.012	1.121	3.746
Catsup, 6.8 kilograms	1.292	1.088	3.060
Apples, 680.4 kilograms	74.544	95.256	176.904
Bananas, 56.7 kilograms	5.103	19.845	34.587
Blackberries, 34 kilograms	26.860	12.580	28.220
Blueberries, 30.4 kilograms	13.680	4.560	13.984
Crab apples, canned, 11.6 kilograms	.812	1.044	1.972
Cranberries, 13.6 kilograms	2.856	1.632	4.624
Currants, dried, 4.5 kilograms	7.605	3.420	8.110
Pineapple, canned, 5 kilograms	1.250	.900	.700
Prunes, 9.1 kilograms	5.733	7.644	18.564
Raisins, 7.7 kilograms	3.234	5.390	18.480
In total food	7,122.250	2,898.787	20,571.960
In cooked food not eaten and in waste (19 per cent)	1,353.227	550.769	3,908.672
In food eaten	5,769.023	2,348.018	16,663.288
Per man per day	1.461	.668	4.741

DIETARY WITH LARGE AMOUNT OF MILK (NO. 152).[a]

Meat and vegetable foods were selected as under ordinary conditions and milk was furnished freely with a view to determining the effect on the amount and cost of the nutrients actually consumed. The study began October 21, 1895, and continued 49 days. Meals taken by men, 11,083; by women, 470. Total equivalent to 1 man for 3,851 days. The food eaten furnished 120 grams of protein and 3,990 calories at a cost of 25 cents per man per day.

The table following shows the kind and amount of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 37, p. 45.

Estimated ash constituents in dietary study No. 152.

Food materials used.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Meats: Beef, veal, venison, mutton, pork, poultry (total meat protein, 174 kilograms)	132.240	330.600	4,002.000
Fish, etc.: Clams, halibut, oysters, salmon (total fish protein, 20.7 kilograms)	37.260	47.610	579.600
Eggs, 108 kilograms	100.000	16.200	396.360
Butter, 153.3 kilograms	33.726	1.533	47.523
Milk, 4,712 kilograms	8,104.640	848.160	10,225.040
Mincemeat, 7.7 kilograms	3.388	2.849	14.707
Flour, crackers, and macaroni, 996.2 kilograms	278.936	259.012	2,151.792
Graham flour, 30.8 kilograms	11.396	46.200	208.280
Cake, frosted, 2.7 kilograms	.567	.513	4.374
Cake, fruit, 0.7 kilogram	.147	.133	1.134
Cake, sponge, 10 kilograms	2.100	1.900	1.620
Cookies, sugar, 3 kilograms	.630	.570	4.860
Corn meal, 39.5 kilograms	3.555	62.140	180.910
Cornstarch, 22.2 kilograms	....	....	....
Hominy, 6.8 kilograms	.952	13.328	48.144
Maple sirup, 25 kilograms	50.184	40.800	40.800
Molasses, 25 kilograms	88.750	44.000	33.000
Oatmeal, 86.2 kilograms	67.236	214.638	839.588
Rice, 2.3 kilograms	.276	1.380	4.554
Sugar, 502.1 kilograms	....	....	....
Tapioca, 6.8 kilograms	....	....	....
Pie, apple, 9.1 kilograms	2.730	2.730	9.100
Pie, cream, 5.9 kilograms	2.360	1.770	8.850
Beans, dried, 98.3 kilograms	211.345	247.716	1,079.334
Beans, string, 57.2 kilograms	41.756	28.600	52.052
Beets, 16.3 kilograms	3.097	4.727	15.485
Cabbage, 37.2 kilograms	21.576	7.812	30.132
Carrots, 9.1 kilograms	7.007	2.912	8.554
Celery, 4.5 kilograms	4.230	1.215	4.500
Horse-radish, dried, 1.3 kilograms	1.768	.494	1.651
Onions, 27.2 kilograms	10.880	4.080	21.760
Peas, canned, 44.9 kilograms	10.327	15.266	63.758
Peas, dried, 38.9 kilograms	53.293	79.356	332.595
Cucumber pickles, 27.2 kilograms	7.616	4.896	14.144
Potatoes, 1,193.4 kilograms	190.944	477.360	1,718.496
Sweet potatoes, 63.5 kilograms	15.875	12.065	50.800
Pumpkin, canned, 25.9 kilograms	8.288	3.626	34.965
Squash, canned, 10.9 kilograms; squash, fresh, 67.1 kilograms	24.960	10.920	105.300
Tomatoes, canned and catsup, 56.3 kilograms	10.697	9.008	25.335
Apples, 547.5 kilograms	60.225	76.650	142.330
Apple sauce, 5 kilograms	.350	.450	.830
Apricots, dried, 19.05 kilograms	186.690	169.545	518.160
Bananas, 39 kilograms	3.510	13.650	23.790
Blueberries, canned, 5.4 kilograms	14.700	4.900	15.190
Cranberries, 5.4 kilograms	1.134	.648	1.836
Currants, dried, 5.4 kilograms	9.126	4.104	9.612
Grapes, 18.6 kilograms	2.604	3.534	12.090
Currant jelly, 29 kilograms	9.280	4.930	13.630
Prunes, 34 kilograms	21.420	28.560	69.360
Raisins, 24 kilograms	10.080	16.800	57.600
In total food purchased	9,871.851	3,169.790	23,219.565
In cooked food not eaten and in waste (19 per cent)	1,875.651	602.260	4,411.717
In food eaten	7,996.200	2,567.530	18,807.848
Per man per day	2.076	.666	4.883

It will be seen that in all of these dietaries milk was quite freely used as compared with food habits the country over, and the amounts of lime and magnesia were liberal in all cases and the amount of phosphorus appears to be entirely adequate in view of the fact that all of the subjects were grown.

It is, however, a very noticeable fact and one of great importance to practical dietetics that, in these experiments made under perfectly normal conditions on a large scale and with no reference (at the time) to the ash constituents of the food, the most expensive dietary furnished the smallest amounts of each of the three ash constituents

here studied. This is in accordance with the present general tendency to rate as of especially high quality foods which are either naturally poor in ash or have been "refined" to such an extent as to largely deprive them of their natural ash constituents. The most conspicuous examples are to be found among the foods of vegetable origin, such as refined sugar and starch, polished rice, and similar foods. It is therefore of especial interest to note that in this case the selection of the more expensive animal foods tends also to result in a lowering of the desirable ash constituents of the dietary.

Comparing the amount of lime per man per day in the different dietaries of this series it will be seen that in both cases on changing from a more expensive dietary to a less expensive one containing more milk there was an increase of over 25 per cent in the amount of lime furnished per man per day. The amount of magnesium was not noticeably affected by the change in either case, and the phosphorus was in one case increased and in the other decreased by something less than 10 per cent. It is chiefly in the calcium content, therefore, that the dietary was improved when a part of the more expensive proteid foods was replaced by a more liberal supply of milk.

An experimental dietary study (No. 486)[a] upon an individual subject, made in connection with the study of iron in food and nutrition, may also be noted here. The primary object of this study was to determine whether it is feasible to obtain a palatable and satisfactory diet rich in iron without the use of meat, eggs, or the more expensive fruits and vegetables, and without employing unusual articles or combinations of food.

The cost as compared with that of family dietaries under like conditions was very moderate. The iron content which has been discussed in detail in a previous bulletin was high. From the data given in the accompanying table it will be seen that the amounts of calcium, magnesia, and phosphorus were also largely increased over those found in most of the family dietaries selected for discussion in this bulletin.

The study was made during fourteen days of January, 1906. The food eaten furnished 100 grams of protein and 3,188 calories at a cost of 27.8 cents per day.

The table below shows the kinds and amounts of foods used, together with the estimated amounts of lime, magnesia, and phosphoric anhydrid furnished by each and by the diet as a whole.

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 185, p. 62.

Estimated ash constituents in dietary study No. 486.

Food material and weight of edible portion.	Calcium oxid.	Magnesium oxid.	Phosphorus pentoxid.
	Grams.	*Grams.*	*Grams.*
Milk, 15,196 grams	26.137	2.735	32.975
Butter, 300 grams	.066	.003	.093
Lard and pork, clear fat, 497 grams	....	....	....
Bread ("entire wheat") 3,315 grams	2.718	2.652	9.249
Crackers, 310 grams	.086	.080	.669
Wheat breakfast food, 1,545 grams	.664	3.692	14.615
Beans, peas, dried, 680 grams	1.462	1.713	7.466
Potatoes, 1,195 grams	.191	.478	1.720
Vegetable soup, condensed, canned, 625 grams	.162	.131	.663
Apples, evaporated, 215 grams	.079	.116	.260
Bananas, 895 grams	.080	.313	.545
Prunes, 400 grams	.252	.336	.816
Raisins, 1,335 grams	.560	.934	3.304
Peanuts, 365 grams	.229	1.036	.686
In total food eaten	32.686	14.219	72.961
Per man per day	2.33	1.02	5.21

From the results of all of these experimental dietaries it may safely be said to have been demonstrated that the desirable ash constituents can readily be increased by proper selection of food materials without decreasing the attractiveness or increasing the cost of the dietary.

CONCLUSION.

To facilitate comparison of the ash constituents of American dietaries with each other and with the protein content, the results of the work described above upon 20 typical dietaries are brought together in the following table, in which the studies are arranged in order of the amounts of protein consumed per man per day:

Comparative summary of ash constituents in typical dietaries—Quantities per man per day.

Dietary study No.	Persons studied.	Fuel value.	Protein.	Iron (Fe).	Phosphoric acid.	Calcium-oxid.	Magnesium oxid.
		Calories.	*Grams.*	*Gram.*	*Grams.*	*Grams.*	*Grams.*
391	Maine lumbermen	6,780	179	0.035	5.88	1.27	1.21
91	School superintendent's family, Chicago	3,260	123	.021	3.97	1.09	.55
207	Students' club, University of Tennessee	3,595	123	.019	4.05	1.22	.63
190	Decorator's family, Pittsburg	3,305	112	.019	3.44	.90	.48
45	Farmer's family, Connecticut	3,545	108	.021	3.53	1.15	.55
44	Teacher's family, Indiana	2,780	106	.016	3.64	1.42	.44
485	Teacher's family, New York City	3,180	102	.017	3.92	1.69	.54
181	Mechanic's family, Tennessee	4,060	97	.017	3.58	.90	.72
182	Farmer's and mechanic's family, Tennessee	2,820	95	.019	3.56	.83	.50
191	Glassblower's family, Pittsburg	3,085	94	.016	2.73	.49	.36
43	Lawyer's family, Pittsburg	3,280	91	.015	2.82	.83	.40
323	Women students' club, Ohio	3,330	85	.015	2.88	.97	.67
112	Laborer's family, New York City	2,335	84	.014	2.41	.47	.30
128	Laborer's family, Pittsburg	2,525	83	.013	2.40	.50	.34
139	Negro farmer's family, Alabama	4,955	80	.012	3.25	.21	.74
129	Laborer's family, Pittsburg	2,440	77	.012	1.52	.40	.19
35	Laborer's family, New York City	2,430	71	.012	2.27	.50	.29
208	Farm students' club, Tennessee	3,560	66	.011	2.08	.46	.34
48	Sewing woman's family, New York City	1,500	54	.009	1.84	.68	.23
100	Very poor negro family, Alabama	2,240	44	.007	2.05	.08	.52

It will be seen from this table, as has been pointed out in a previous bulletin, that the amounts of iron in the different dietaries are approximately proportional to the amounts of protein. In a general way, and so far as it goes, this observation tends to confirm the common assumption that a diet containing liberal amounts of protein is likely to furnish at the same time liberal, or at least adequate, amounts of iron. Evidently, however, it can not be assumed that liberal quantities of protein involve adequate amounts of all of the ash constituents. As a rule the dietaries rich in protein are also fairly high in phosphoric acid, but the parallel is not nearly so close here as in the case of protein and iron. With calcium and magnesium the discrepancies are greater, and it can hardly be said that the amounts of these elements run even approximately parallel to the amounts of protein in the twenty dietary studies which have been compared and which are believed to be fairly representative of the food habits of people of at least the eastern half of the United States. In view of these figures it can no longer be assumed that the amount of protein in a dietary is a sufficient measure of its richness in "building material." Aside from nitrogen, the elements of "building material" which appear to require special attention in dietaries are iron, phosphorus, and calcium.

The occurrence and distribution of iron in foods, its functions in nutrition, and the question of iron supply in dietaries, has been discussed in another bulletin. The outline above given of the distribution and functions of phosphorous and calcium compounds, while of necessity incomplete, is yet sufficient to show the great importance of these compounds in the nutritive processes and to emphasize the necessity for adequate supplies in the food.

Of the various classes of phosphorous compounds found in food, the organic combinations appear in general to be of greater nutritive value than the inorganic forms, and it is probably for this reason that different experiments indicate quite different amounts of phosphorus as necessary for the maintenance of equilibrium in man. From the results here obtained, as well as from the average results of experiments by other observers, it would appear that a healthy man, accustomed to full diet of the ordinary mixture of animal and vegetable food materials, requires for the maintenance of his ordinary store of phosphorous compounds about 1.5 grams of phosphorus, or nearly 3.5 grams of phosphoric acid, per day, though under special conditions or with a specially selected dietary equilibrium may be maintained on much less. Many of the dietary studies show so much less than 3.5 grams of phosphoric acid per man per day as to raise a question whether these people may not have been undernourished in this respect, even though they may have had ample proteins, fats, and carbohydrates. This question merits further investigation.

Little is known regarding the form in which calcium exists in food materials, and at present differentiation among the different groups of calcium compounds eaten can not be made. Metabolism experiments indicate that a healthy man accustomed to full diet requires about 0.7 gram of calcium oxid for equilibrium, but many of the dietaries show less than 0.7 gram calcium oxid per man per·day. Gautier in France and Albu and Neuberg in Germany hold that the food should furnish at least 1 to 1.5 grams calcium oxid per man per day. If these estimates of the normal requirement and the estimates of the amounts in typical American family dietaries are even approximately correct, it would follow that a considerable proportion of American families would be benefited by food richer in calcium compounds than that which they habitually consume. This subject calls for much more extended study, especially in view of the fact that recent medical observations are tending to show that disturbances of calcium metabolism are connected with a number of abnormal conditions.

Experimental dietary studies have shown that it is entirely feasible to increase largely the calcium and phosphorus intake by making a more liberal use of milk in the dietary. The same may, of course, be said of the various milk products in which the calcium and phosphorus compounds are largely or wholly retained, such, for example, as cheese, junket, kumiss, buttermilk, or cream. This is probably the simplest and more effective means of improving the dietary as regards calcium and phosphorus compounds, without decreasing its acceptability or materially increasing its cost and with distinct advantages in other directions.

The progress of research during the four years which have elapsed since the above-described experiments were performed and most of the foregoing text was written has still further emphasized the importance of calcium and phosphorus in food and nutrition.

227

O

THE AGRICULTURAL COLLEGES.

ALABAMA—*Auburn:* Charles C. Thach.[a] *Normal:* W. S. Buchanan.[a] *Tuskegee:* Booker T. Washington.[b]

ARIZONA—*Tucson:* Kendrick C. Babcock.[a]

ARKANSAS—*Fayetteville:* C. F. Adams.[c]

CALIFORNIA—*Berkeley:* E. J. Wickson.[c]

COLORADO—*Fort Collins;* C. A. Lory.[a]

CONNECTICUT—*Storrs:* C. L. Beach.[a]

DELAWARE—*Newark:* Geo. A. Harter.[a] *Dover:* W. C. Jason.[a]

FLORIDA—*Gainesville:* A. A. Murphree.[a] *Tallahassee:* Nathan B. Young.[a]

GEORGIA—*Athens:* A. M. Soule.[a] *Savannah:* R. R. Wright.[a]

HAWAII—*Honolulu:* J. W. Gilmore.[a]

IDAHO—*Moscow:* E. E. Elliott.[c]

ILLINOIS—*Urbana:* E. Davenport.[c]

INDIANA—*Lafayette:* J. H. Skinner.[c]

IOWA—*Ames:* Albert Boynton Storms.[a]

KANSAS—*Manhattan:* H. J. Waters.[a]

KENTUCKY—*Lexington:* J. K. Patterson.[a] *Frankfort:* John H. Jackson.[a]

LOUISIANA—*Baton Rouge:* Thos. D. Boyd.[a] *New Orleans:* H. A. Hill.[a]

MAINE—*Orono:* George Emery Fellows.[a]

MARYLAND—*College Park:* R. W. Silvester.[a] *Princess Anne:* Frank Trigg.[b]

MASSACHUSETTS—*Amherst:* K. L. Butterfield.[a]

MICHIGAN—*East Lansing:* J. L. Snyder.[a]

MINNESOTA—*University Farm, St. Paul:* A. F. Woods.[c]

MISSISSIPPI—*Agricultural College:* J. C. Hardy.[a] *Alcorn:* L. J. Rowan.[a]

MISSOURI—*Columbia:* F. B. Mumford.[c] *Jefferson City:* B. F. Allen.[a]

MONTANA—*Bozeman:* Jas. M. Hamilton.[a]

NEBRASKA—*Lincoln:* E. A. Burnett.[c]

NEVADA—*Reno:* Joseph E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* Wm. D. Gibbs.[a]

NEW JERSEY—*New Brunswick:* W. H. S. Demarest.[a]

NEW MEXICO—*Agricultural College:* W. E. Garrison.[a]

NEW YORK—*Ithaca:* H. J. Webber.[d]

NORTH CAROLINA—*West Raleigh;* D. H. Hill.[a] *Greensboro:* James B. Dudley.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Columbus:* H. C. Price.[c]

OKLAHOMA—*Stillwater:* J. H. Connell.[a] *Langston:* Inman E. Page.[a]

OREGON—*Corvallis:* Wm. J. Kerr.[a]

PENNSYLVANIA—*State College:* Edwin E. Sparks.[a]

RHODE ISLAND—*Kingston:* Howard Edwards.[a]

SOUTH CAROLINA—*Clemson College:* W. M. Riggs.[e] *Orangeburg:* Thomas E. Miller.[a]

SOUTH DAKOTA—*Brookings:* R. L. Slagle.[a]

TENNESSEE—*Knoxville:* C. D. Schmitt.[c]

TEXAS—*College Station:* R. T. Milner.[a] *Prairie View:* E. L. Blackshear.[b]

UTAH—*Logan:* J. A. Widtsoe.[a]

VERMONT—*Burlington:* M. H. Buckham.[a]

VIRGINIA—*Blacksburg:* P. B. Barringer.[a] *Hampton:* H. B. Frissell.[b]

WASHINGTON—*Pullman:* E. A. Bryan.[a]

WEST VIRGINIA—*Morgantown:* D. B. Purinton.[a] *Institute:* Byrd Prillerman.[a]

WISCONSIN—*Madison:* H. L. Russell.[c]

WYOMING—*Laramie;* Chas. O. Merica.[a]

[a] President. [b] Principal. [c] Dean. [d] Acting dean. [e] Acting president.

1272 Issued August 15, 1910.

U. S. DEPARTMENT OF AGRICULTURE,

OFFICE OF EXPERIMENT STATIONS—BULLETIN 228.

A. C. TRUE, Director.

PROCEEDINGS

OF THE TWENTY-THIRD ANNUAL CONVENTION
OF THE ASSOCIATION OF

AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS

HELD AT

PORTLAND, OREG., AUGUST 18–20, 1909.

Edited by

A. C. TRUE AND W. H. BEAL,

FOR THE OFFICE OF EXPERIMENT STATIONS,

and

W. O. THOMPSON,

FOR THE EXECUTIVE COMMITTEE OF THE ASSOCIATION.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1910.

THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Ph. D.—Director.

E. W. ALLEN, Ph. D.—Assistant Director and Editor of Experiment Station Record.

W. H. BEAL, B. A., M. E.—Chief of Editorial Division.

[Bull. 228]

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., April 9, 1910.

SIR: I have the honor to transmit herewith for publication Bulletin 228 of this Office, containing the proceedings of the Twenty-third Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Portland, Oreg., August 18–20, 1909.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

OFFICERS AND COMMITTEES OF THE ASSOCIATION.

President.

W. J. KERR, of Oregon.

Vice-Presidents.

H. J. WATERS, of Kansas; C. A. LORY, of Colorado; W. P. BROOKS, of Massachusetts; P. H. ROLFS, of Florida; L. FOSTER, of New Mexico.

Secretary and Treasurer.

J. L. HILLS, of Vermont.

Bibliographer.

A. C. TRUE, of Washington, D. C.

Executive Committee.

W. O. THOMPSON, of Ohio, *Chairman;*
J. L. SNYDER, of Michigan; W. H. JORDAN, of New York; W. E. STONE, of Indiana; C. F. CURTISS, of Iowa.

OFFICERS OF SECTIONS.

College Work and Administration.

S. AVERY, of Nebraska, *Chairman.*
W. D. GIBBS, of New Hampshire, *Secretary.*
Program Committee.—The Chairman and Secretary of the Section.

Experiment Station Work.

F. B. LINFIELD, of Montana, *Chairman.*
H. L. RUSSELL, of Wisconsin, *Secretary.*
Program Committee.—The Chairman and Secretary of the Section, and W. H. BEAL, of Washington, D. C.

Extension Work.

A. M. SOULE, of Georgia, *Chairman.*
G. I. CHRISTIE, of Indiana, *Secretary.*

STANDING COMMITTEES.

Instruction in Agriculture.

For three years, J. F. DUGGAR, of Alabama, and W. E. STONE, of Indiana; for two years, A. C. TRUE, of Washington, D. C., *Chairman*, and T. F. HUNT, of Pennsylvania; for one year, H. J. WATERS, of Kansas, and H. C. WHITE, of Georgia.

Graduate Study.

For three years, W. O. THOMPSON, of Ohio, and BROWN AYRES, of Tennessee; for two years, H. P. ARMSBY, of Pennsylvania, *Chairman*, and HOWARD EDWARDS, of Rhode Island; for one year, M. H. BUCKHAM, of Vermont, and EUGENE DAVENPORT, of Illinois.

Extension Work.

For three years, A. M. SOULE, of Georgia, and E. A. BURNETT, of Nebraska; for two years, K. L. BUTTERFIELD, of Massachusetts, *Chairman*, and C. R. VAN HISE, of Wisconsin; for one year, W. C. LATTA, of Indiana, and C. F. CURTISS, of Iowa.

Experiment Station Organization and Policy.

For three years, M. A. SCOVELL, of Kentucky, and L. G. CARPENTER, of Colorado: for two years, EUGENE DAVENPORT, of Illinois, *Chairman*, and C. D. WOODS, of Maine; for one year, H. J. WHEELER, of Rhode Island, and E. B. VOORHEES, of New Jersey.

[Bull. 228]

LIST OF DELEGATES AND VISITORS IN ATTENDANCE.

Arizona: J. J. Thornber, delegate.

Arkansas: J. N. Tillman and C. F. Adams, delegates; G. A. Cole, visitor.

California: E. J. Wickson, delegate; E. E. Kaufman, H. W. Smith, W. H. Volck, and C. W. Woodworth, visitors.

Colorado: C. A. Lory and L. G. Carpenter, delegates; C. P. Gillette and W. P. Headden, visitors.

Delaware: H. Hayward, delegate.

Florida: P. H. Rolfs, delegate; A. W. Stewart, visitor.

Georgia: A. M. Soule, delegate; T. H. McHatton, visitor.

Idaho: J. A. MacLean, E. E. Elliott, and J. H. Frandson, delegates; H. T. French, R. E. Hyslop, C. D. Mason, J. R. Shinn, E. H. Twight, and F. P. Van Hook, visitors.

Illinois: E. Davenport, delegate; Mrs. E. Davenport, Miss M. Davenport, A. G. Hughes, W. E. McDermut, A. A. Norton, and C. J. Rosbrook, visitors.

Indiana: W. E. Stone and A. Goss, delegates; G. I. Christie, W. C. Latta, and J. H. Skinner, visitors.

Iowa: A. B. Storms and C. F. Curtiss, delegates.

Kansas: H. J. Waters and E. H. Webster, delegates; E. R. Nichols and Mrs. E. R. Nichols, visitors.

Kentucky: H. Garman, delegate.

Louisiana: W. R. Dodson, delegate.

Maine: G. E. Fellows and C. D. Woods, delegates; W. A. Martin, visitor.

Maryland: R. W. Silvester, delegate.

Massachusetts: K. L. Butterfield, W. P. Brooks, and W. R. Hart, delegates; Mrs. K. L. Butterfield, J. L. Ellsworth, and F. W. Rane, visitors.

Michigan: J. L. Snyder and R. S. Shaw, delegates.

Minnesota: J. W. Olsen, delegate.

Mississippi: J. C. Hardy and W. L. Hutchinson, delegates; S. M. Tracy, visitor.

Missouri: F. B. Mumford, delegate.

Montana: F. B. Linfield, delegate.

Nebraska: S. Avery and E. A. Burnett, delegates; Mrs. S. Avery, Mrs. E. A. Burnett, A. E. Davisson, and V. Keyser, visitors.

Nevada: J. E. Stubbs and S. B. Doten, delegates.

New Hampshire: W. D. Gibbs, delegate.

New Jersey: W. H. S. Demarest, delegate.

New Mexico: W. E. Garrison and L. Foster, delegates; Mrs. L. C. Foster, visitor.

New York: L. H. Bailey, J. Craig, and W. H. Jordan, delegates; D. I. Duncan, R. A. Pearson, and B. von Herff, visitors.

North Dakota: J. H. Worst and E. F. Ladd, delegates; Mrs. E. F. Ladd and Mrs. J. H. Worst, visitors.

Ohio: H. C. Price and C. E. Thorne, delegates; A. D. Selby, visitor.

Oklahoma: J. H. Connell, delegate; J. C. Elliott, visitor.

Oregon: W. J. Kerr, J. Withycombe, and R. Withycombe, delegates; H. C. Atwell, J. A. Bexell, C. E. Bradley, J. C. Bridwell, Miss L. Collamore, A. B. Cordley, J. Dryden, Miss J. Green, C. R. Greisen, F. L. Kent, C. I. Lewis, E. R. Lyman, L. D. Mahone, L. T. Reynolds, H. D. Scudder, E. A. Shepard, H. V. Tarter, E. Tausch, C. D. Thompson, H. Umberger, and J. Wiseman, visitors.

Pennsylvania: T. F. Hunt, delegate; Miss M. J. Hunt and Mrs. T. F. Hunt, visitors.

Porto Rico: D. W. May, delegate.

Rhode Island: H. Edwards and H. J. Wheeler, delegates; Mrs. H. J. Wheeler, visitor.

South Carolina: T. E. Miller, delegate.

Utah: J. A. Widtsoe and E. D. Ball, delegates; L. A. Merrill, visitor.

Vermont: J. L. Hills, delegate; Miss B. Hills, visitor.

Virginia: H. L. Price, W. B. Ellett, and C. K. Graham, delegates; C. G. Burr and Mrs. C. K. Graham, visitors.

Washington: E. A. Bryan and R. W. Thatcher, delegates; R. K. Beattie, L. W. Hanson, A. L. Melander, S. B. Nelson, O. M. Olson, G. Severance, E. A. Smith, and W. S. Thornber, visitors.

West Virginia: D. W. Working, delegate.

Wisconsin: E. H. Farrington and H. L. Russell, delegates.

Wyoming: C. O. Merica, J. D. Towar, and J. C. Fitterer, delegates.

United States Department of Agriculture: A. C. True, delegate; W. H. Beal and J. Hamilton, visitors, Office of Experiment Stations.

Canada: G. A. Gigault and G. A. Putnam, visitors.

CONSTITUTION.

[Amendments authorized by the Portland convention are shown in italics.]

NAME.

This association shall be called the Association of American Agricultural Colleges and Experiment Stations.

OBJECT.

The object of this association shall be the consideration and discussion of all questions pertaining to the successful progress and administration of the colleges and stations included in the association, and to secure to that end mutual cooperation.

MEMBERSHIP.

(1) Every college established under the act of Congress approved July 2, 1862, or receiving the benefits of the act of Congress approved August 30, 1890, and every agricultural experiment station established under State or Congressional authority, the Bureau of Education of the Department of the Interior, the Department of Agriculture, and the Office of Experiment Stations of the last-named Department, shall be eligible to membership in this association.

(2) Any institution a member of the association in full standing may send any number of delegates to the meetings of the association. The same delegate may represent both a college and a station, but shall vote in only one section and shall cast only one vote in general sessions. Other delegates may be designated by an institution to represent it in specified divisions of the sections of the association, but such delegates shall vote only in such divisions, and no institution shall be allowed more than one vote in any sectional meeting.

(3) Delegates from other institutions engaged in educational or experimental work in the interest of agriculture or mechanic arts may, by a majority vote, be admitted to conventions of the association, with all privileges except the right to vote.

(4) In like manner, any person engaged or directly interested in agriculture or mechanic arts who shall attend any convention of this association may be admitted to similar privileges.

SECTIONS.

(1) The association shall be divided into *three* sections: (*a*) A section on college work and administration, (*b*) a section on experiment station work, (*c*) *a section on extension work composed of directors or superintendents of extension departments in the institutions in this association, or the representatives of such departments duly and specifically accredited to this section.*

The section on college work and administration shall be composed of the presidents or acting presidents of colleges and universities represented in the association, or other representatives of such institutions duly and specifically accredited to this section, and no action on public and administrative questions shall be final without the assent of this section.

The section on experiment station work shall be composed of the directors or acting directors of experiment stations represented in the association, or of other representatives of such stations duly and specifically accredited to this section.

(2) Members of these *three* sections (and no others) shall be entitled to vote both in general sessions and in the section to which they respectively belong.

The representative appointed by the United States Bureau of Education shall be assigned to the section on college work and administration; the representative of the Office of Experiment Stations to the section on experiment station work; and the representative of the United States Department of Agriculture to either section as he may elect and the section by vote authorize; but such election once made and authorized may not be changed during the sessions of a given convention.

Each section may create such divisions as it may from time to time find desirable, and shall elect its own chairman and secretary for sectional meetings whose names shall be reported to the association for record.

(3) Each section shall conduct its own proceedings, and shall keep a record of the same, and no action of a section, by resolution or otherwise, shall be valid until the same shall have been ratified by the association in general session, and in the case provided for in the foregoing paragraph (1) shall also have been approved by the section on college work and administration.

MEETINGS.

(1) This association shall hold at least one meeting in every calendar year, to be designated as the annual convention of the association. Special meetings may be held at other times, upon the call of the executive committee, for purposes to be specified in the call.

(2) The annual convention of the association shall comprise general sessions and meetings of the sections, and provision shall be made therefor in the program. Unless otherwise determined by vote, the association will meet in general session in the forenoons and evenings of the convention and the sections in the afternoons.

OFFICERS.

(1) The general officers of this association, to be chosen annually, shall be a president, five vice-presidents, a bibliographer, and a secretary, who shall also be treasurer; and an executive committee of five members, three of whom shall be chosen by the section on college work and administration and two by the section on experiment station work: *Provided, however*, That a member chosen by either section need not be a member of that section. The executive committee shall choose its own chairman.

(2) Each section shall, by ballot, nominate to the association in general session for its action a chairman and a secretary for such section.

(3) The president, vice-presidents, secretary, and bibliographer of this association shall be elected by ballot upon nomination made upon the floor of the convention, and shall hold office from the close of the convention at which they are elected until their successors shall be chosen.

(4) Any person being an accredited delegate to an annual meeting of the association, or an officer of an institution which is a member of the association in full standing at the time of election, shall be eligible to office.

DUTIES OF OFFICERS.

(1) The officers of the association shall perform the duties which usually devolve upon their respective offices.

(2) The president shall deliver an address at the annual convention before the association in general session.

(3) The executive committee shall determine the time and place of the annual conventions and other meetings of the association and shall between such conventions and meetings act for the association in all matters of business. It shall issue its call for the annual conventions of the association not less than sixty days before the date on which they are to be held, and for special meetings not less than ten days before such date. It shall be charged with the general arrangements and conduct of all meetings called by it. It shall designate the time and place of the convention. It shall present a well-prepared order of business—of subjects for discussion—and shall provide and arrange for the meetings of the several sections. The subjects provided for consideration by each section at any convention of the association shall concentrate the deliberations of the sections upon not more than two lines of discussion, which lines, as far as possible, shall be related. Not more than one-third of the working time of any annual convention of the association shall be confined to miscellaneous business.

FINANCES.

At every annual convention the association in general session shall provide for obtaining the funds necessary for its legitimate expenses and may, by appropriate action, call for contributions upon the several institutions eligible to membership; and no institution shall be entitled to representation or participation in the benefits of the association unless such institution shall have made the designated contribution for the year previous to that in and for which such question of privilege shall arise, or shall have said payment remitted by the unanimous vote of the executive committee.

AMENDMENTS.

This constitution may be amended at any regular convention of the association by a two-thirds vote of the delegates present, if the number constitute a quorum: *Provided*, That notice of any proposed amendment, together with the full text thereof and the name of the mover, shall have been given at the next preceding annual convention and repeated in the call for the convention. Every such proposition of amendment shall be subject to modification or amendment in the same maner as other propositions, and the final vote on the adoption or rejection shall be taken by yeas and nays of the institution then and there represented.

RULES OF ORDER.

(1) The executive committee shall be charged with the order of business, subject to special action of the convention, and this committee may report at any time.

(2) All business or topics proposed for discussion and all resolutions submitted for consideration of the convention shall be read and then referred,

without debate, to the executive committee, to be assigned positions on the program.

(3) Speakers invited to open discussion shall be entitled to twenty minutes each.

(4) In general discussions the ten-minute rule shall be enforced.

(5) No speaker shall be recognized a second time on any one subject while any delegate who has not spoken desires to do so.

(6) The hours of meeting and adjournment adopted with the general program shall be closely observed, unless changed by a two-thirds vote of the delegates present.

(7) The presiding officer shall enforce the parliamentary rules usual in such assemblies and not inconsistent with the foregoing.

(8) Vacancies which may arise in the membership of standing committees by death, resignation, or separation from the association of members, shall be filled by the committees, respectively.

[Bull. 228]

PROCEEDINGS OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

MINUTES OF THE GENERAL SESSION.

Morning Session, Wednesday, August 18, 1909.

W. E. Stone, of Indiana, member of the executive committee, called the meeting to order at 10 o'clock a. m., at the Commercial Club, of Portland, Oreg., and designated W. J. Kerr, of Oregon, first vice-president of the association, to act as the presiding officer in the absence of the president, M. A. Scovell, of Kentucky.

Prayer was offered by Rev. D. Dyott, of Portland.

After the call of the roll of the delegates the report of the executive committee was presented by W. E. Stone in the absence of the chairman of the committee, W. O. Thompson, of Ohio.

The report was received and placed on file. For further action on it see page 24.

Report of Treasurer.

The treasurer, J. L. Hills, submitted the following report:

Report of treasurer, November 18, 1908, to August 18, 1909.

GENERAL FUNDS.

Receipts:	
To cash on hand Washington meeting	$1,394.76
To 95 dues	1,425.00
Total	2,819.76
Disbursements	1,382.38
Balance on hand in July, 1909	1,437.38
Classification of disbursements:	
Executive committee	743.93
Research committee	81.58
Committee on conference with President Taft	381.81
Representative before Carnegie Foundation	73.15
Stenographer, college section	65.80
Secretary-treasurer	34.11
Chart, President Butterfield	2.00
Total	1,382.38

GRADUATE SCHOOL SUBSCRIPTION FUND.

Receipts: To 22 subscriptions	550.00
Disbursements: Committee on graduate study	171.68
Balance on hand July, 1909	378.32

The accounts of the treasurer were audited and approved by a committee appointed by the chair, consisting of R. W. Silvester, of Maryland, and E. Davenport, of Illinois.

Report of Bibliographer.

The bibliographer, A. C. True, of Washington, D. C., submitted the following report:

The subject to which your bibliographer wishes to call attention this morning especially is the experiment station library. With the increase of funds and workers I am convinced that there is need of more systematic attention on the part of the stations to their library and bibliographical work. I am not speaking so much now of the general library requirements. The college library may properly include the station library and all books belonging to the station as a department of the college may properly be catalogued in the general college library. But as a rule the general college arrangement for library service is not sufficient to meet the needs of the station. Many of the institutions show great liberality in the purchase of scientific and technical books and journals required by the station work, and this is certainly to be commended. There are some institutions, however, that have not yet felt the need of supplying the station workers with the highest class of scientific literature, which is very essential to their work, and this matter should receive the serious attention of all the institutions with which the stations are connected.

But whatever the details of the library arrangement for the institution as a whole may be, the station needs special collections of books, journals, and documents which shall be primarily for its use and shall be made readily and constantly available to the station workers. The station should also have, if possible, the services of some person trained in library and bibliographical matters who may give his time and energy quite fully to the special requirements of the station along these lines.

There is now a great accumulation of public documents, both national and state, and privately issued publications of miscellaneous kinds bearing on the work of the stations, and I am referring now especially to matters outside of the regular periodical publications, and particularly to the more fugitive publications which are difficult to trace and follow out. Much of this material, which is valuable to station workers, can be had at little or no expense as regards its purchase. It is quite difficult for the individual investigator or expert to follow up such matters even in his own line, and he needs the assistance of some one who will make it his special business. The collection, safeguarding, and general care of this material is a considerable task, and I am sure that there are quite a number of our stations where this work is not as yet adequately attended to.

In the special matter of public documents my observation and experience indicate that the stations, and I think this is also true of the colleges, have not as yet sufficiently regarded the importance of keeping their files of such documents complete and in readily available form. The impression seems to be still widespread that such documents if lost can be easily replaced. There does not seem to be the care of them, therefore, that there is of ordinary books. But anyone who has to deal with this matter at close range knows that many of the public documents, and especially those that have some particular value, when once lost can not be replaced, and hence there is need of care in preserving them. Of equal importance is the making of the contents of this mass of material available to the station worker. It is true we have the Experiment Station Record, which contains a brief summary of such publications generally, but I believe that beyond the use of that publication there is need of definite bibliographical work on behalf of the station worker.

The station investigations may be greatly aided and promoted by having some person who can assist in looking up references, making excerpts, making and taking care of indexes, and doing bibliographical work of a miscellaneous character. The matter of exchanges and loans of publications through the Department of Agriculture, through the other colleges and stations, through local libraries which are especially rich in useful material, is also important.

To cover the work which I have in mind the stations do not need a librarian in the ordinary acceptation of the term, but rather what may be called a bibliographical aid, i. e., some one who has scientific knowledge and who is properly trained so as to give efficient aid in bibliographical matters to the station staff.

And it may be urged in connection with this matter that such service is not very expensive. There is now a fairly good supply of people sufficiently well trained for this work who can be obtained at relatively low salaries, and the matter seems to me of sufficient importance to receive careful attention.

Turning aside from that matter, there are two books to which I wish to call the attention of the association as of special interest and importance. These books have been published within the past year and so are properly included in my annual report as bibliographer. One of these is the Encyclopedia of Agriculture prepared under the leadership of a distinguished member of this association and very largely contributed to by men included in this association. That work I am sure you will all agree is of very great importance to the movement for agricultural education and research in this country, as well as to the wider movement for agricultural progress. The putting of the accumulations of our agricultural experiment stations and other similar institutions and agencies into readily available form for reference in such works is, at the present stage of education and research in agriculture in the United States, of prime importance; and the presentation of agricultural information for the general reader in up-to-date fashion is also, in my judgment, of very great importance.

A smaller work, but one of very considerable interest, is a book on the Methods of Agricultural Instruction. This was prepared by M. De Vuyst, of Belgium. He is the general inspector of agricultural experiment stations in that country. He is also familiar with agricultural institutions in this country because he has spent some time here. His work is of interest to many of us because we know him personally. He has attempted for the first time to bring together in summary form a statement of the organization and methods of agricultural education in different countries and in institutions of different grades, and has produced a book which is of considerable importance at the present time. It is published in the French language in Brussels.

The report was accepted.

Secondary Education in Agriculture in the United States.

A. C. True made the following address:

I propose first to outline briefly the present status of secondary education in agriculture in the United States.

Twelve years ago, when Secretary Wilson came to the United States Department of Agriculture, there were but 10 agricultural high schools in the country, and the teaching of agriculture in normal schools or in public elementary schools had merely begun. To-day there are 60 agricultural high schools, or definitely secondary agricultural courses in colleges; 346 public high schools teaching agriculture; and 119 state or county normal schools and 16 agricultural colleges training young men and women to teach agriculture. In addition to these there are a number of private institutions giving secondary instruction in agriculture, and 16 institutions offering correspondence courses or reading courses which are practically of secondary grade, making in all about 500 institutions giving secondary instruction in agriculture.

For the purposes of this discussion these institutions may be classified as follows:

(1) The agricultural colleges, where the instruction is given through definitely organized agricultural high schools, as in Minnesota, or through short or special courses of different kinds. The agricultural colleges as a body are giving much secondary instruction in agriculture. In some cases this is definitely organized as such, and in other cases it is given under a variety of names. (2) Agricultural high schools in congressional or other large districts, as in Minnesota and Alabama. (3) County agricultural high schools, as in Michigan and Wisconsin. (4) State or county normal schools. (5) Ordinary high schools either in cities, townships, or counties. (6) Private colleges and schools. (7) Correspondence schools.

In a general way, though very inadequately, I have stated the present scope of instruction in agriculture in secondary schools in this country. It must be said that the movement is still in an experimental stage, and the most encouraging thing about it now is that we have a sufficient number of experiments in this kind of education in progress so that we shall hope to have some pretty definite results worked out from experience within a comparatively short time.

I think we should all agree that it is now too early to say what the American system of secondary education in agriculture will ultimately be. From the study which I have been able to make of this subject I am inclined to sum up the matter from a somewhat ideal point of view in the following statement:

(1) Agriculture, including horticulture and forestry (and it is well to bear in mind that where I use the term agriculture I would use it in the ordinary sense to include the whole subject), should be a regular part of public secondary education; (2) the unity of the educational system should be maintained, but there should be sufficient elasticity of curricula to meet the various needs of the people; (3) the standard curriculum of secondary schools having agricultural courses should conform in a general way to that adopted for the general school system of the State; (4) the standard agricultural courses, whether in the ordinary high schools or in special schools, should not be narrowly vocational, but should aim to fit the pupil for life as progressive, broad-minded, and intelligent men and women, as well as good farmers and horticulturists; (5) the standard courses in agricultural secondary schools should be so organized as to form a natural and proper preparation for entrance to agricultural colleges.

The conditions of entrance requirements to colleges are, in my judgment, far from satisfactory. It is not likely that we have reached the ultimate plan for the preparation of the great mass of students who in the future will desire college courses. It seems certain that when the so-called vocational subjects are properly organized and taught in the secondary schools they will be generally recognized as having much pedagogical value. This is especially true of agriculture, which is a subject embracing much of general human interest. Even under present conditions the agricultural colleges would do well to give credit in their entrance requirements for agricultural subjects properly taught in secondary schools.

The agricultural college should have a definite legal relation to our public-school system, and especially to the courses or schools of agriculture of secondary and elementary grades. By this I mean that the state legislatures should take definite action recognizing that agricultural colleges have a definite function to aid in the organization of a proper system of secondary instruction in agriculture, and help the secondary schools in that work.

One difficulty now in the progress of this movement is that in quite a number of States the legislation is such that the agricultural colleges, if they take any part in it, have to "butt in." The whole matter of secondary education is in many States intrusted to the state department of education, as far as the State deals with the matter. I think that ought to be remedied. It may be said that that is only part of a wider thing. I do not believe that we have yet in this country considered definitely enough the proper relation of our universities and colleges to the more elementary education. These higher institutions in many States yet stand too much apart from our general system of education. It is very desirable, it seems to me, that they should be recognized by statute everywhere as an essential part of our system of public education. And while that general movement is proceeding the friends of agricultural education should urge that the agricultural colleges should have a definite part in the organization and maintenance of systems of agricultural education in public schools.

Agricultural colleges will have to do secondary work to a considerable extent for some time to come. We can not, in my judgment, jump immediately in all our agricultural colleges to a state of things where all the secondary work is excluded. This should, however, be definitely organized as separate and distinct from the college work. The aim should be to have all secondary work relegated to secondary schools, entirely separate from the colleges, when such schools are efficiently organized with reference to instruction in agriculture.

Agriculture should be generally introduced into the ordinary high schools. There should also be a limited number of special agricultural high schools in the different States. These should be so limited in number that they will be organized with reference to large districts. I do not believe it is either necessary or desirable to organize such schools with the county as the unit. Experience so far points to the fact that the county is too small a unit for the proper equipment and maintenance of a thoroughgoing agricultural high school. These special schools should have a relatively large agricultural faculty and an adequate equipment, so that students going to them will not only have offered to them a standard course of high school or secondary grade, but will

also have opportunity to specialize to a certain extent along different agricultural lines. I believe that such schools are needed, because they will in a way set the pace for secondary education in agriculture, and will help rather than hinder the general introduction of agriculture into the ordinary high schools. Besides serving more general purposes, they will attract a good many of the more mature students, who are not ready or financially able to go to college, but desire to go somewhere to get some definite instruction in agriculture, and who are really too old to feel comfortable in the ordinary high school. These schools will also aid in the preparation of teachers and school officers for the rural schools; so that in a way these special agricultural schools will more fully meet the need which is now being met to a limited extent by the special and short courses in the agricultural colleges.

As I said, I believe the standard courses in these special agricultural schools should not be narrowly vocational, but should conform, in a general way, to the general standard for the high-school system in the State, and they should be organized so as to connect them definitely with the general educational system of the State. To do this it will probably be found necessary in the case of schools that have shortened the school year to twenty-four weeks of six days each, instead of thirty-six weeks of five days each, to add another year to the standard course, making it five years instead of four. But it would be desirable that besides the standard courses which would prepare the student for college or for life, as the case might be, such schools should have shorter courses more purely vocational.

To illustrate the kind of special agricultural school which might be organized in accordance with the principles set forth in his paper, Doctor True presented the syllabus of a four-year secondary course in horticulture, prepared for an association of horticulturists, in which English, algebra, geometry, history, botany, chemistry, and French or German, together with some electives, were combined with a course in horticulture to which the student was required to give at least one-fourth of his time during four years and might give about one-third, if all the horticulture offered in electives was taken. A two-year course was also outlined in which one-half the time would be devoted to horticulture. A similar arrangement of courses was recommended for general agriculture.

T. F. Hunt, of Pennsylvania. A question has been raised as to just what Doctor True meant by the legal relation which should exist between the agricultural colleges and the secondary schools.

A. C. True. I meant that the state legislature should take definite action recognizing that agricultural colleges have a definite function to aid in the organization of a proper system of secondary instruction in agriculture, and help the secondary schools in that work.

H. C. Price, of Ohio. I think the situation in Ohio is worthy of consideration. Just before leaving home I had letters from presidents of two of the small colleges of the State as to how they might arrange their courses of study so as to include agriculture, and also what modification they might make in their courses of study so as to prepare their students for admission in our college with credit for the first two years of our courses. There are between forty and fifty colleges in Ohio, and necessarily some of them are relatively weak. Some of these institutions are located in most excellent agricultural communities, and their constituency is necessarily largely local.

The two problems that have arisen in connection with these institutions are, first, how can their work be coordinated with our college of agriculture so that at least the first two years of our course can be taken in the local institution; and, second, what can they do in giving technical instruction that will serve as the finishing course for the students who attend them. I have no doubt that this same question is arising in other States and will have to be dealt with in the near future.

E. A. Bryan, of Washington. I would like in a word to express my very hearty assent to the suggestion that in so far as possible we should aim at a reorganization of the existing system of secondary education; that is, in the modification of our present educational system in the direction of industrial education we attempt to utilize in so far as possible the existing system. We must remember in the first place that it is well organized in all States of the Union. The existing system of secondary education has ample provision in the way of taxation. It has an organization. It has the confidence of the people. The people believe in our system of public education, and it seems to me that it is very much wiser upon our part, instead of attempting to establish a duplicate system of secondary education, to modify, so far as possible, the existing system in this direction. It can be done easily for the reason that the people in general are looking in this direction. They believe in the fundamental principles which the agricultural college stands for and they are ready to modify the curriculum of any and every high school in this direction. I believe, furthermore, in the suggestion of Doctor True that in the several States a few agricultural high schools should be established—distinctly agricultural high schools—and they should conform as far as possible to the existing system and be an integral part of the public-school system, and that the curriculum itself should conform in the main to the general standard and general ideals of the existing high-school system, with the addition, of course, of these particular courses. In that respect the suggested course in horticulture which he has outlined to us commends itself very strongly to my judgment. In fact, I wish to express my very hearty approval of the entire set of principles suggested by Doctor True. I should be glad to circulate in my State 10,000 copies of the remarks just made by Doctor True.

A. B. Storms, of Iowa. I want to express myself in a similar way in indorsement of these principles as laid down by Doctor True. I would like to move the adoption of this report, which would of course carry with it the approval of this association of the principles there enunciated. I think it is a most admirable statement and one that would do great good.

J. L. Snyder, of Michigan. I have never been convinced that the separate agricultural secondary school was advisable in the majority of our States. I believe that agricultural education will progress more rapidly without the introduction of that type of school in our State, and in that particular I would respectfully dissent from the report. Now, it may be that in some States the cause will be advanced by the introduction of a few of the secondary schools. I believe in the main they are a snare and a delusion as far as the general progress of agricultural education is concerned and that we should not encourage them.

E. A. Burnett, of Nebraska. I rise only to suggest that a limited number of secondary agricultural schools may be established in a State without seriously modifying the educational system now established and without being out of harmony with the present system. Such schools might be established under a joint management, by which the present state boards or departments of education would be mainly responsible for the school, and in that case I do not see that there could be the difficulties which have been suggested.

C. F. Curtiss, of Iowa. I think the position that Doctor True has taken upon this question is conservative and eminently sound, and I think the association can well afford to indorse that position. It will be difficult enough for the agricultural colleges to furnish teachers to do the work in the special agricultural high schools that may be established in addition to those required by the high schools now in existence. These special agricultural high schools

will train teachers for the work in the high schools in the system now in existence. One of the great difficulties, perhaps the greatest difficulty in the way of the practical development of this work, is that of securing teachers. The high schools can not command the services of the best graduates turned out by the land-grant colleges for the reason that they do not feel justified in paying or are not able to pay the salaries that will command the best talent. I think that the secondary schools, if they serve no other purpose, would serve an excellent purpose in helping to train the teachers for this extension of the work in the public schools. I trust the association can give its indorsement to the position taken by Doctor True.

E. Davenport, of Illinois. I would be inclined to agree with President Snyder in this matter but for the fact that the kind of special agricultural school that Doctor True outlines is just the kind of a school that we need and ought to have. It is not very much of a special agricultural school, for it provides that one-quarter of the time of the students shall be devoted to agriculture. I do not agree with the view that special agricultural schools will provide teachers for agricultural work. Nor do I agree that the high schools will be able to pay sufficient salaries to get the right kind of teachers.

E. J. Wickson, of California. In California we have two distinctly agricultural high schools, one established by the State and one established by the College of Agriculture, both doing good work. They are serving as most excellent models for the high schools which desire to introduce agriculture as part of their course. The courses of study that we are following in those two distinctly agricultural high schools are being imitated by the regular high schools so far as they go with the subject. In regard to teachers, our agricultural high schools are actually preparing teachers. Dean Davenport says they can not, but they do. Of course, they are not agricultural teachers of very high grade, but they are taking hold of agricultural subjects which our people insist upon.

A. B. Cordley, of Oregon. If we are to have agricultural high schools which might serve as models for other high schools, well and good; but if we are to have agricultural high schools which will be vocational schools I am opposed to them. It seems to me that the agricultural colleges are going to have more than they can possibly do to train teachers for the high schools, and that it is much more important for the agricultural colleges to get in touch with the organized regular school work than to attempt to foster a special line of work.

J. L. Snyder. We have in our State one agricultural school organized as such, its course of study modeled after the Wisconsin agricultural schools. It is vocational, just as the other separate agricultural schools are. Now, we have also in the State one high school, and will have six next year, that has organized an agricultural department. It has employed an agricultural college graduate who is given about 20 to 25 per cent of the students' time for agricultural work. Now, in my judgment, there is no comparison between those two schools, the one is simply a training school, the students in the school are young and immature. They are there simply to get a little training to help them to run their farms. The other is a dignified four-year course and leads to something educational as well as practical. Next year we will have six such schools. I believe that it is a mistake for this convention to place itself upon record as indorsing the establishment of separate agricultural schools. I should teach agriculture as manual training has been taught throughout the country, as part of our educational system.

E. A. Bryan. I desire to second the motion. I think, in the first place, we ought to modify our high-school system in this direction. If it was desirable to have a very few schools we might establish agricultural high schools in each

State, modeled on the outline suggested by the speaker, our graduates filling the teachers' positions. But I would be one of the first to oppose the establishment of a duplicate system of secondary schools in the United States. I think it would be foolish in every respect. I think it would be foolish also to establish a large system of schools comparatively vocational. We may indeed modify our existing system of high schools in this direction. We may add to them here and there a few distinctively industrial schools modeled very much on the same plan as the regular high schools, supported in the same way, conforming to the same general system, and for the same purposes. It seems to me that is precisely the conservative position which this convention ought to indorse.

C. D. Woods, of Maine, moved that the motion of President Storms be amended by placing the word "accept" in place of the word "adopt."

A. B. Storms. A word on the amendment. I made the motion to adopt for the express purpose of securing the indorsement of this association to the principles as enunciated by Doctor True. I think the bugaboo that President Snyder sees is one of his own conjuring. It never would have occurred to anybody listening to this report, I believe, impartially, without any previous dreams, that it was intended to indorse or approve or to secure, if possible, the establishment of such schools as he speaks of. It might be so perverted, but it would be a perversion. The outline of a system of agricultural schools as there given is an admirable one. Schools are being established in some of the States. If so, I would say they surely should have a good guide. Where could we get a better one than the one suggested by Doctor True?

Personally, I feel that we should be very conservative in any State about establishing special training or vocational schools; but if they are to be established in any State, it seems to me they should be modeled after such a plan as this, and I wish that we might find a practically unanimous approval of this plan. Things are in a state of transition. Public opinion is forming. Legislatures are likely to act and sometimes act unwisely if there is not a guide for their action.

L. H. Bailey, of New York. I am wondering whether the discussion would not be clarified if we had a definition of what is meant by secondary education. The discussion seems to assume that secondary education covers all grades of educational work not distinctly collegiate. But it does not. The term "secondary," as applied in school organization has a definite meaning. Winter-course work, as ordinarily conducted, is not secondary education. It is special education. So, the work of these particular vocational schools of which President Snyder and others have been speaking is not "secondary" work. It is a special work. I feel, however, no matter how many special or separate schools of agriculture there may be, the agricultural colleges always will do winter-course work. There will always be persons wanting particular training in this branch or that, who will come to a winter school. Some of those who would now go to the winter course in the college will in time, I hope, go to the agricultural school, but there will still remain a large class of young persons who want to go farther than the school can take them or to particularize more closely, these persons will come to the agricultural college; they will not be satisfied with the equipment and facilities of the special local schools, no matter how good these schools may be. We need to distinguish between secondary work, special or separate work, and the winter-course work in colleges; they are in different categories.

K. L. Butterfield, of Massachusetts. I hope that the motion of Doctor Storms will prevail. Doctor True's address is a lucid statement of the position that I

think we can afford to take at the present time. There is need just now of some such summary, for the question of agricultural education of a secondary grade is still in a chaotic condition. It would be wise if this association could agree upon some such platform as Doctor True has announced.

Personally, I would not like to vote for the resolution of President Storms if it seemed to imply that the statement by Doctor True is a statement of ultimate principles, all the details of which are to be carried out in the future development of our system of agricultural education. But it seems to me that for present purposes Doctor True's platform is admirable. So far as I can interpret the movement that is under way in our part of the country, there is surely going to be a place for the separate vocational school of agriculture of a grade substantially that of the present high school, though I think that such a school will eventually take pupils who are somewhat more mature than the average high-school pupils. Our system of agricultural education will not be complete until we have developed a complete system of vocational agricultural schools of a secondary grade. Such schools should be an organic part of our public-school system. This process may take a generation; it may take two generations.

Furthermore, I feel confident that during the next two decades we are going to reorganize our idea of what constitutes a vocational course. Some of the subjects of study as enumerated by Doctor True will be eliminated. Social subjects, which at present are not included, will some time be subjects of study in these schools. But as an expression of opinion for a present program, it seems to me that Doctor True's statement is most admirable.

J. A. MacLean, of Idaho. I would like to ask whether it is not possible to secure several thousand advance copies of this report. The paper is so important and so valuable and so timely, and the conditions in many of the States make the need of it so great, that I hope it will be found possible to secure the publication of several thousand advance copies of this paper.

A. C. True. I am very much surprised and somewhat overwhelmed by the way in which this paper has been received. If I had realized that this matter was coming up in this form I fear I should have hesitated to come before the association with my remarks in such a form as they have been presented. If it is desired that this matter should be put in form for publication, and publication made, as has been the custom, through the Office of Experiment Stations as a circular, I think that can probably be brought about at an early date.

I agree in many particulars with a good many of the remarks that have been made by various gentlemen who commented upon the paper. With Dean Bailey, for instance, I should agree that in the careful consideration of this matter there should be a definition of secondary instruction, and also that the agricultural colleges will always need to give special instruction. The most important matter for the consideration of the association relates to the general character of these special agricultural schools, which are being established in a considerable number of States. The judgment of the association upon that point would also affect a wider question. We are running very rapidly in this country toward the establishment of courses and institutions for vocational training, and for myself I fear that there will not be proper consideration given to the character of such courses and institutions. It looks as if we were to have upon a wide scale a revival of the old trade-school ideas and the insistence in many quarters on the establishment of institutions with narrowly vocational courses. I do not believe that is a wise thing, and especially am I opposed to that kind of institution for agricultural education. The properly trained farmer should be much more than a mere manual worker. He should be a broad-

minded citizen, a home maker, and should be fitted for life in the country in a broad way.

I therefore think that in our present state of progress and trend of movement it is a very important thing for this association to consider the matter of these schools in a broad way, and if it does anything I should hope, certainly, that it would indorse the idea that such institutions should be broadly organized rather than that they should be narrowly vocational.

The motion to accept rather than adopt the views set forth in the paper was lost.

The original motion that the views expressed in the paper be adopted was carried.

On motion of C. D. Woods, of Maine, the secretary was instructed to send a telegram to President M. A. Scovell and to W. O. Thompson, chairman of the executive committee, expressing the regret of the association at their absence.

Recommendations of Executive Committee.

On motion of E. Davenport, the chair was instructed to appoint a committee to consider the recommendations contained in the report of the executive committee.

The chair appointed on this committee E. Davenport, of Illinois; A. B. Storms, of Iowa; and E. A. Bryan, of Washington. (See report, p. 45.)

On motion, a recess was taken until 8 o'clock p. m.

Evening Session, Wednesday, August 18, 1909.

The association was called to order at 8 p. m. by Vice-President Kerr.

Report of Committee on Graduate Study.

The report of this committee was presented by Howard Edwards, of Rhode Island, in the absence of the chairman, H. P. Armsby, of Pennsylvania, as follows:

The resignation from the committee of Dean L. H. Bailey and the retirement of President R. H. Jesse brought about a change of one-third of the membership of the committee, and left it without a chairman. The vacancy caused by Dean Bailey's resignation was filled by the appointment, by the president of the association, of President Howard Edwards, of Rhode Island. After some unavoidable delays, Dean Eugene Davenport, of Illinois, was chosen by the committee to fill the vacancy caused by President Jesse's retirement, and H. P. Armsby was elected chairman of the committee. The committee presents at this time a report of progress.

The first official action of the committee was the unanimous election of Dr. A. C. True as dean of the summer school, and, with the consent of the Secretary of Agriculture, Doctor True has accepted the position. The committee feels that it is very fortunate in being able to continue the administration which has made previous sessions of the school so successful, and takes this opportunity to express its obligations to Doctor True for his willingness to undertake the arduous duties of the deanship, and to the honorable Secretary of Agriculture for the interest which he has again manifested in authorizing Doctor True to serve the association in this capacity.

After full correspondence between members of the committee, including the dean, and with the authorities of the Iowa State College, the invitation of that institution to hold the graduate school of 1910 at Ames, Iowa, was unanimously accepted, and on June 19, 1909, the committee, together with Dean True, met at Columbus, Ohio, for conference with President A. B. Storms and Dean C. F. Curtiss, of the Iowa State College, regarding plans for the session. A general outline of the course was presented by Dean True and approved by the com-

mittee, subject to such modifications of details as may prove necessary. The following is an outline of the proposed course:

The programme of the graduate school of 1910 will include courses in plant physiology and pathology, agronomy, horticulture, animal husbandry, dairying, rural engineering, and rural economics. There will also be public opening exercises and a number of meetings for the discussion of general topics in agricultural pedagogy, agricultural extension work, country-life problems, conservation of natural resources, and similar topics.

Announcements regarding local arrangements will be made later by the registrar appointed by the Iowa State College.

The committee desires also to ask the attention of the convention to the important matter of the financial support of the graduate school. It scarcely seems necessary to present any arguments regarding the importance of graduate work. The phenomenally rapid widening of the field of educational effort in agriculture, as well as the rapid growth of the demand for scientific investigation, has at once emphasized the importance of thorough training of the investigator and teacher and tended to diminish the relative supply of qualified men. No more important problem faces the institutions represented in this association than that of fostering advanced study in agriculture and related subjects on the part of those who presumably are to become the leaders of agricultural progress in the next generation.

As is well known to the members of the association, the support of the graduate school is derived from three sources: First, the special contributions made by institutions represented in the association; second, the registration fees of students; and, third, the contribution by the holding institution. In accordance with the action of the association the committee, under date of May 12, 1909, called upon each college and each independent experiment station represented in the association for the regular contribution of $25 for the year ending June 30, 1909. Up to the date of this meeting the treasurer of the association reports the payment of this contribution by 22 institutions. It is the earnest hope of the committee that those institutions which have not already contributed to this undertaking will forward their contributions to the treasurer at an early date. A similar contribution will be called for later for the year 1909–10.

It should be clearly understood that this contribution is entirely separate from and in addition to the regular dues of the association. The contributions made under this action constitute a special fund in the treasury, which is used only for the payment of the expenses of the graduate summer school. On the basis of the expenses of the past two schools, it may be conservatively estimated that the amounts available from the contributions of the colleges and stations and from students' fees will fall short of the total expense of the school by approximately $1,500, which deficit must be borne by the holding institution. While thus far no difficulty has been experienced on this score in locating the school, such a contribution is, nevertheless, a heavy tax upon a single institution for the benefit of all. It would seem that if the institutions concerned are not willing to increase the amount of contribution now authorized, they should, at least, if the school is to remain an undertaking of the association, feel under obligations to contribute the comparatively small amount asked for, except, of course, in the few cases where legal difficulties seem to interpose.

H. P. ARMSBY,
HOWARD EDWARDS,
M. H. BUCKHAM,
W. O. THOMPSON,
BROWN AYRES,
Committee.

THE BETTER PREPARATION OF MEN FOR COLLEGE AND STATION WORK.

L. H. Bailey, of New York, presented the following paper on this subject:

The colleges of agriculture are at last established and are well accepted in the public mind. It is no longer necessary to apologize for them or even to defend them. Therefore we are free to devote our attention to the internal constructive evolution of them.

We are now beginning to be consciously concerned in the development of a thoroughly good and sound rural civilization. The colleges of agriculture will

be the most important agencies in this evolution. Therefore these colleges carry immense responsibilities.

The colleges of agriculture must train farmers.[a] They must also train the trainers of farmers. This double work must be clearly recognized and the instruction must be developed to meet it. It is not to be expected that when the college meets the needs of its constituency, however well it meets them, it thereby meets the needs of those who would be trained to be teachers and investigators. The college that makes no adequate distinction between these two lines of service ought not to undertake to train men for the best leadership work, or to expect that even the best men from the graduating classes will be fitted for it.

If the college of agriculture represents rural civilization, then it follows that its work must be of divers kinds and that it will attract men and send out men of many divergent types of mind. As the college of agriculture is a state institution, being endowed by all the people, it owes itself to all rural-minded residents of the commonwealth. It must do good research work, for on this rests the value of its effort; it must teach those who come to it, if they have proper qualifications; it must extend itself to all the people in the commonwealth, for in the end all the people will matriculate, even though they remain at home on the farms. In all these three lines, also—in research, in regular college teaching, in extension effort—men and women must be trained for forthcoming positions; some of the colleges of agriculture must undertake to train them. Agriculture is becoming a broad and commanding subject; the colleges of agriculture must continue to meet the situation, and they must have well-trained men and big men.

Perhaps I have often enough expressed my convictions in respect to the subjects connoted in this introduction, but I am not averse to making one last excussion into them. I shall make a leisurely excursion, for I want to get the view. I shall go a good ways around, but I shall get home in the end.

I shall ask you to look at (1) the necessity of developing a spirit of scientific inquiry; (2) the necessity of letting one's work propagate itself; (3) the necessity of developing an incentive of self-help in one's constituency; and (4) the necessity of insisting on a certain kind of preparation in college.

I. THE NEW LEADER MUST HAVE THE SCIENTIFIC SPIRIT.

The college that trains him inoculates the spirit into a man. I speak of spirit before I speak of the curriculum, because it is the more important. The teacher or the investigator sent out by the college of agriculture is to discover and know the truth, and then to found his statements on it. It is permissible that his statements be clever and entertaining in their method, but they will be founded on fact and on reasonable deductions from fact if they are worthy of him.

These sentences may seem to be mere trite statements; and therefore I shall enlarge on them, for I am convinced that if the colleges of agriculture do the work they are called to do we shall develop a new order of rural government and a new purpose in rural civilization. What I am now about to say is not framed so much for those who have arrived at responsible positions in the institutions as to make suggestions to such young persons as contemplate engaging in country-life work. No person is prepared for college and station work who does not possess the scientific spirit.

It is very difficult for any of us to divest ourselves of tradition and of the notions that have come with us from birth or from childhood. Most of us have positive opinions on a great many subjects on which we have no real knowledge whatever. I often say to my students that they come to college with a

---

[a] In this paper (as elsewhere in my writings) when I speak of colleges of agriculture I have in mind the agricultural side of the work of the land-grant colleges, or of any institutions of similar purport (as those in Canada), and irrespective of whether they are connected with universities or stand by themselves. Of course I do not mean to say that the work of the land-grant college should all be agriculture, for, by law, these institutions must include the mechanic arts and other branches of learning related to our fundamental industries. I have no kind of desire to magnify the agricultural work over the mechanical and engineering work that they are under equal obligation to perform; I speak of the agricultural side because it is my subject and because I have given no attention to the other side.

whole body of notions and opinions, and the probability is that every one of them is wrong. The larger part of the maxims and "wise saws" by which we guide our lives are probably either untrue, only partially true, or are misleading and unsafe as guides.

We are living in a time when it is considered to be right for a man to inquire, to see for himself, and to draw his own conclusions, for there are many things to find out, and the human mind is inquisitive.

We are living in the epoch of evidence. News gathering and gossiping aside, we do not depend on hearsay, nor on opinion, but on the fact and the reasons. We want proof. We are asking what truth is, and then we are not assuming that it is this or that, but are demanding the fact rather than a statement of the authority of any man.

We are living in a time when we are not afraid of our own conclusions. Men have been under bondage to other men from the first. They have been under bondage to the king or ruler, to the priest, to the capitalist, to the politician, and to current public opinion. Gradually we are passing out of our bonds and are becoming free. We now enjoy physical freedom, but relatively few persons in the world are really free to think as they will or to draw their own conclusions. While they may not know it, very few persons really want to know the truth. Very few, relative to the whole number, have open minds.

Our conclusions should follow naturally as a result of a line of work, and it matters not whether anybody is pleased with them or not. An honest man can withhold nothing in the search for truth, nor color his opinions for any person or for any benefit to himself, or detract anything except on new evidence or a new consideration of the subject. When he arrives at a conclusion, he speaks; and when he speaks, he stands.

We are living in a time of integrity of thought. By this I mean that we follow our thought out to its logical end, and that we do not in any way modify or shade our opinions in order to meet anybody's preconceived notions or to fit our ideas into the frame of thought of our time. It is the obligation of the investigator to know no other criterion than truth. If fame attracts him to modify his opinions, he is not a scientific man. If he modifies or understates or overstates his scientific conclusions because he is afraid of them, or because he desires to win favor anywhere or with anybody, then he does not have a really scientific mind and does not have integrity of thought, and he is not honest. He does not go where the truth leads him. Darwin wrote well toward the end of his life, "I am sure that I have never turned one inch out of my course to gain fame."

That is, we are beginning to think as individuals, and not as masses. I do not mean by this that men are to work wholly as individuals, for it is only by community of effort that we can expect to accomplish the best results for each other and for the world. By removing extraneous interests, the spread of the scientific spirit should enable men and women to work together without conflict, and it should develop a fine idealism. I know that the scientific man is often hard and lacks resiliency, but there is no necessity that it should be so.

Now, if this spirit were to guide all men it would revolutionize all our business; for a large part of the business of the world is essentially morally unhonest, even though it may conform itself perfectly to the statutory law. It would also revolutionize our politics, for it would take out of political operation the element of expediency and compromise which now dominates it. And it would shatter much of the theology that we now think we believe.

There is just as much need that we develop politics and government on a scientific method as that we develop chemistry, or botany, or physiology on that method. It is first necessary actually to study the conditions and to determine what are the real facts; then on these facts to establish a constructive procedure and to let the whole question of favor and of patronage be forgotten. Government by patronage and by influence is a phase of an undeveloped and unhonest society. Only as we found government on evidence and develop it in the scientific spirit can we expect to have really good government, or to make the best progress in civilization.

There is a peculiar disagreement of method in the work of many men as between their week-day attitude toward the world and their Sunday attitude. I see this in persons who are giving their lives to scientific investigation. They may be good scientists in their laboratories, in the sense that they search for fact and are exceedingly cautious not to express even an opinion that is not founded on evidence, and yet when they are out of their laboratories they accept the most impossible reactionary dogmas and theories which have no

foundation, so far as we can discover, in either fact or reason. I always distrust the science of such men; or at all events, a presumption is raised in my mind as to whether a man who does not have complete integrity of thought on one subject is likely also to have it on another. I recognize, of course, that in science and elsewhere we must accept much on faith; but the faith should be reasonable.

The scientific man never sets out to prove anything. He starts out to find what is true. He divests himself of all preconceived notions as to what the result is to be. He merely wants to know what is the fact, and if the fact that he discovers to-day contradicts the fact that he discovered yesterday, or even contradicts his own public statement of yesterday, he is the first man to acknowledge and to publish the contradiction; and he finds as much satisfaction in the discovery as if he had not made an imperfect conclusion the day before. I knew an experimenter who was very much disappointed that his experiments did not prove his theory, and he therefore discarded his experiments. I knew another who refused to undertake certain experiments because he was afraid that they would disprove the Bible. It is really a rare quality in a man that he is able to withhold his conclusions until he has all the evidence. I am afraid that most of us draw our conclusions and afterwards begin to prove them. That is, we prejudge, or are controlled by prejudice.

These remarks ought to have application to everyone of us whether we are investigators or not, and whether or not we are following a business that is founded on scientific fact. Our type of mind determines our attitude toward the world in which we live. There are very few of us, I am afraid, who have a perfectly rational and natural outlook on the world of nature. We are inclined rather to look on the forces of nature as in antagonism with us rather than to put ourselves directly into line with nature and try to work with her rather than against her. It is interesting to catch this note through all the history of mankind and in our literature. The thunder, the lightning, the storm, the wind, and much else, have been thought of as forces which are by nature opposed to us and with which we must necessarily contend. This idea, whether consciously or unconsciously, has entered into our customary attitude of life and is expressed in our poetry, our dogmas, and in our creeds. I should like to do something, if I can, to enable mankind to overcome the traditional and theological fear of nature.

Our traditional idea of God as a ruler who sits on a distant throne and manages the universe is another expression of our unsympathy with nature, because we put God above, beyond, and outside of nature. The modern outlook is to recognize God in nature.

The beginning of all real rural development is a rational outlook on the part of those who live in the open country. Country people must interpret nature from cause to effect rather than by tradition, notion, or prejudice. The colleges of agriculture and experiment stations are doing just this for country people. Beyond all "practical" application of the work of these institutions is the new and open-minded attitude that they develop on all problems under discussion. They banish all guessing, all moon farming, and all think so. The farmer is now willing to learn and to cast old notions aside; and for this reason the world is becoming a new world to him and he is beginning to understand his situation. As rapidly as he understands his situation he will master it.

If, now, I have estimated my premises properly, it follows that the attitude of the young leader toward his work is just as important as the work itself; and for this attitude his instructors are in large degree responsible. We are not training advocates, to found a case on part of the evidence; we are not training debaters or argumentarians, to found a position on an assumption; we are not training politicians, to found an action on the chance of securing office. We should be a plain people, saying what we have reason to know and speaking without guile.

The spirit of science, conjoined with spiritual forces, will eventually civilize the world.

II. WE SHOULD BE WILLING TO LET OUR WORK PROPAGATE ITSELF.

Every good leader is enthusiastic. It is a quality of leadership that its own interest in the work is contagious.

But there is great danger that enthusiasm has a narrow view and does not see all the sides and parts of a question. This danger is likely to be intensified

by narrow special courses pursued when the person is young. The great value of what we call a broad foundation lies in its influence in enabling a student to see the relation of one subject to another rather than to immerse him into one subject. I should prefer that the intending teacher or experimenter in agriculture have a good arts and science course in at least his first two years than that he be put into "agricultural" subjects in order that he may not lose interest in them. If he is in danger of losing his interest in agriculture in these years of preparation, society can well afford to stand the loss.

But what I intend most to say is that we may well rest content that our work will propagate itself if the work is well done and enthusiastically presented. We do not need to invoke extraneous aids to bolster or boost the work. The teacher or investigator is under no necessity to become a partisan for his department in order to make it "go." He does not need to buttonhole anybody. The person who develops a buttonhole type of mind is not likely to have a very highly developed science sense.

Education and investigation in agriculture have come to be a public function. They comprise the office of institutions and departments maintained by government, state or national, or both. Of all men, those who represent investigation by government should not be partisan; yet I am persuaded that we are developing a dangerous attitude in the pushing of such work. All government inquiry in the interest of agriculture is scientific inquiry in its last analysis. The persons who represent it should take the attitude of scientific men, and should not feel called on, in order to establish themselves in a region or a subject, to proselyte, or to act as if they were agents of commercial establishments engaged in drumming up business.

The growth of their work must rest on the excellence of it, and on their enthusiasm and enterprise in performing it.

III. THE ATTITUDE TOWARD CONSTITUENCY.

The good agricultural worker must have something of the missionary in him. He must know enough of the farm conditions to have the farm point of view, and possess enough human interest to make him desire to help everybody. Yet he must understand that his best work with his state or national constituency is that which inspires his constituency to help itself. His mission is not to carry people, but to enable them to walk alone.

A society of ginseng growers recently made a purse to call in a plant pathologist to make investigations of ginseng diseases. This illustrates a very important principle. The college of agriculture or the experiment station of the State can not find the funds to meet all the difficulties in the State, and the people should be willing to contribute money for the solution of the problems of their special business or region. It is no doubt the part of the institution or of farmers' institutes or other agencies to set backward neighborhoods into action, but it does not follow that the institution should forever carry the neighborhood or industry. As a neighborhood becomes prosperous it should be glad to help those who are less fortunate.

If a stock-growing community is perplexed by a feeding problem or a pear-growing community is injured by pear blight, let the people unite and call the best advice. If investigations are needed that the college or experiment station can not undertake, let the people collect a purse of, say, $600 a year for two or three years and have the institution send a special postgraduate or advanced student into the region to work the problem out under the immediate direction of the college authorities. This would give the locality the benefit of the most expert help at the minimum cost, and it might be helping a needy and worthy student at the same time. In this way the locality could have the distinction and satisfaction of maintaining what would be practically a scholarship or fellowship, and the people would become active cooperators in the public work of the State. In very many cases this method would be far better than the common practice of running to the legislature with every difficulty, and it would eliminate the necessity of depending for betterment work on the politician and officeholder. It would strongly develop the ability of self-government.

It would also seem that the responsibility of proving the worth of their goods should rest on the firms who make the goods rather than on the college or the experiment station. An experiment station is under no obligation to test seeds or new plants or a new spray mixture just because some firm, for the sake of profit, has put the materials on the market.

It does not follow because a county fair, a farmers' club, or a shipping association asks the college of agriculture or experiment station to send exhibits or a lecturer or an investigator that the institution is under obligation to do so. It may be quite as important that the local organization "prove up," show that it deserves the help, that it will take pains to cooperate and to execute the work. I have known many cases in which the people in the locality sit idly by or look on in curiosity while investigators work hard to throw light on a local problem, and I have gone back into the community years after to find the same difficulties and to hear the same questions as to cause and remedy. This is not fair.

My argument is that those who are in training for college and station work should be interested to understand how their special work will react on the social structure of the community and what psychological effect it will have on the people. The worker must always and always have before him the idea that he is making it possible for his people to think out their own problems and to help themselves. It is easy for him to advise them to go to the legislature or to Washington, but he must be careful that he does not weaken them thereby.

The rural community is inert, chiefly for two reasons: It does not have knowledge; it does not have social cohesion. The community comes to be dominated by personal or parasitic interests. Rural government is probably as much dominated by graft and boss rule, in proportion to population and opportunities, as is city government.

Rural communities need to have their local fact incorporated into their social structure. As agriculture rests on scientific fact, so is it fundamentally important how this fact is worked into the web and woof of the community life. The scientist, speaking broadly, and not the politician, is the person who is going to make the greatest contribution to local rural self-government.

IV. THE CURRICULUM.

I come at last to the subject that you all have had in mind from the beginning, the course of study. I am getting in sight of home. You all know the place so well that I need only to say a few formalities at parting.

I think that the point of view is the first consideration—the curriculum is one of the means of working it out.

In looking over a number of catalogues of universities I was struck by the few persons with less than a doctor's degree who are teaching chemistry and physics, and with the great number not having such degree who are teaching agriculture in the same institutions. Many of the teachers in agriculture and home economics have no degrees. This does not prove that the persons in one case are inferior to those in the other. It is rather an indication of the lack of opportunities that have been at the disposal of the agricultural men for the pursuit of good postgraduate work in their special subjects. It is probable that by subsequent study and experience these officers, even if lacking advanced degrees, are now as well prepared as other persons for their work. The new generation will find better opportunities for preparation, and the attainments of the officers of agricultural colleges and experiment stations will find the academic recognition that they deserve.

In discussing the curriculum we must remember that the first duty of the college of agriculture is to train men by means of agriculture to be competent and useful citizens of the world and to meet the rural needs of its commonwealth. A college may serve its State ever so efficiently and yet not be prepared to train men and women for the higher positions as teachers and leaders. There must be special provision for the training of high-class specialists. Because a man has graduated from a college of agriculture it does not follow that he is fitted for a position in a college of agriculture.

My contention is that we have now come to the time when we must much more closely scrutinize the men who are to officer our colleges of agriculture and our experiment stations. We have now skimmed the surface in agricultural investigation, taking off the apparent and the easy subjects. The constituency is rapidly rising in intelligent appreciation of what we do. We must now go deeper, attack the essential underlying problems, teach more fundamentally. The college of agriculture can now set its standards and let the people rise to meet them. This must come about through officers who are very carefully trained for their duties.

I will state a few specific considerations that I think should govern in the training of persons for college and station work. I have in mind the work in

home economics, as well as in agriculture proper. Of course, such regulations can not apply equally to all persons or in all subjects. Persons may appear who will be above and beyond all regulations, so marked by nature for particular kinds of work that the routine preparation may not be essential for them; but rules are never made for the exceptions, and, moreover, these exceptions will be so very rare that we do not need to consider them in a paper like this.

(1) We must allow our men to mature and ripen to some extent before placing them in full charge of very responsible work, and especially before sending them far away from home. The demand for men is so great that it is difficult to do this, but there is need that we make the effort.

(2) We must appreciate the value of the time element in the training of persons for college and station work. There may be short courses and short cuts for other students, but there should be no short cuts for those who would fit themselves for teachers and experimenters in the colleges and stations.

(3) The person who would fit himself for such work should have the equivalent of a good high-school training, and he should be a regular graduate of a four-years' course founded on such preparation.

(4) He should then have a thorough post-graduate training. He ought in the future to have at least an earned master's degree, and the time ought soon to come when he should have an earned doctor's degree. I know that we can not yet insist on all this, but I think that we should begin to set these prerequisites for all heads of departments. It has not been possible to accomplish this up to this time, both because of the rapid demand for men and the lack of opportunities to secure these degrees in agricultural subjects.

(5) In order that a post-graduate degree may mean something, it is important not only that the post-graduate work itself is good, but that only those persons be allowed to candidacy who give evidence of being intelligently able to pursue the work with satisfaction. It does not follow that because a student has secured his bachelor's degree he may therefore demand as a right that he pursue graduate work in any subject; the officer in charge of that subject should have the right to refuse an applicant who is clearly too weak to make a good teacher or investigator in the subject. In practice the weak men are not usually weeded out in the final examination for the degree. Persons who would pursue post-graduate work merely because they can find nothing else to do should be eliminated.

(6) This means (if a man secures his doctorate) that he can not be through with his training short of 23 years, assuming that he enters college at 16 years, which is the earliest age. But even the twenty-third year is too young for one to have completed a doctorate. If the candidate is so unfortunate as to have entered college at 16 years, it would be better for him to drop out a year or two after graduation and engage in such work as will give him experience in life. In fact, it is usually advisable for the general student to enter on his post-graduate work with more experience than a college course alone can give him.

This deliberate preparation would do much to give us the mature men that we so much need. Such men are specially needed in agriculture, because people follow their advice in the making of a living. A person who accomplishes anything in the world will make errors, but some kinds of errors are more serious than others. It would not matter very much if one made a bad blunder in the study of sun spots, but to give wrong scientific advice on the raising of wheat or the growing of apples or the rearing of live stock is a grave responsibility.

Before a person is allowed a post-graduate degree in agriculture I think he should have covered at least the following preparation:

(*a*) A usable knowledge of at least French or German.

(*b*) Enough of physics, chemistry, physiology, biology, geology, meteorology, to enable him to understand the bearing of his work, and to guard him from fundamental error.

(*c*) A usable interest and understanding in the social and economic phases of country life.

(*d*) Sufficient actual contact with farm work and farm life to make him competent to estimate the farmer's position and to judge the rural mind.

(*e*) And he should have completed a piece of personal investigation of a character that calls for the exercise of much more talent than merely the ability to be industrious and to compile.

There is now opportunity to secure the necessary preparation in the chemistry and the physiology and the pathology that underlie our work; but in the applications of these things to life there are not yet adequate facilities for the training of men and women for college and station work nor I fear, sufficient appreciation of the importance of it. This is marked in such subjects as animal breeding, dairying, horticulture, poultry husbandry, farm mechanics, rural architecture, rural education, rural economy, and, above all, in what we call home economics. I gave the best of my life to one of these applications, but I did not see the whole problem then. My estimate is now a backward look; but I rejoice to see the good young men and women coming on.

I have now traversed my field, just for the pleasure of seeing how it lies. I have pointed out some of the most apparent things. It is a beautiful field that we travel in, this broad field that I like to call "the open country." In it are all the possibilities of man's desire; it is ours to develop and establish them. We will make it the equal of any other field of man's effort. We do not need to be in haste. We need more than all to be prepared for our work, that we may see correctly, think straight, work together as brothers, and have in mind the best good of all men. We shall all contribute our best performance, each in his special way, but we shall do it with all the field before our eyes and with a proper understanding of our part in the whole enterprise.

I have made this journey unexpectedly, but I have had good company, and I thank you all for going with me.

The association adjourned until 10 o'clock a. m., August 19.

Morning Session, Thursday, August 19, 1909.

Vice-President Kerr called the association to order at 10 o'clock a. m.

Conservation of our Natural Resources.

L. G. Carpenter, of Colorado, read the following paper on this subject:

Recently much attention has been given to our natural resources, to the imminent danger of their exhaustion, and the fearful calamities that would happen to our descendants, mostly in the remote future. I would not lessen the attention that has been given, for it has exercised a useful purpose and has been of great benefit in causing the arrest of attention and a sober thought to be given to a study of the tendencies of production and of consumption. At the same time I am not impressed with all of the somber colors of the painting. One is struck with the supreme confidence of the prophets in their complete knowledge of present resources, the boldness with which they dismiss consideration of any possible developments of which they do not know, and their evident belief that the coming generation will be a helpless and resourceless lot, not capable of solving any problems which we of this generation can not see. It is not so long ago as to be forgotten when a celebrated gentleman determined to his satisfaction that because the human race increased in geometrical proportion while the production of human food increased in arithmetical ratio, that therefore the time would soon come when the race would suffer from starvation, and that therefore it was the duty of the intelligent and the public spirited to prevent this catastrophe. To this day the descendants have continued to increase, and never before has there been more abundant food supply than to-day. The prophets in such cases have been satisfied with the sufficiency of their own knowledge, have tacitly assumed that discoveries have ceased, and that the condition of practice and of knowledge remains as it is to-day and is measured by their own information.

Their mistake has been in omitting consideration of the one most important resource. This is the present and acting human will and enterprise, the power to surmount obstacles, to change conditions, to discover and adapt new means—a tenacious, intelligent, resourceful will. Progress is always coming to the end of its road, and then a sudden turn, due to an additional discovery or a new resource, shows the road continuing in another direction and again without end until another obstacle will be reached and passed in the same manner. But even in the case of any given resource, it is again assumed that we know all of the existing supplies, an assumption that it is safe to say is generally untrue. Even within a year in the case of some of the natural supplies which were

thought to be near extinction additional supplies have already been discovered and the estimate of the time of extinction is correspondingly further removed and we are comforted with the assurance that we have a longer period of activity. We are making adaptation of new processes and discoveries. Not many years ago there might have been the fear of darkness in the home, for cattle could not furnish tallow for the growing need—the whale was disappearing. Then with the adaptation of coal oil came the alarm concerning the exhaustion of the oil supply. Then arises the adaptation of the electric current, and this again is being utilized so as to furnish many times the same light for the same energy that it could a few years since. It is only an illustration from a common matter of information that the human mind under the stimulus of necessity or self-interest finds new methods unsuspected before. These steps are not seen by the common mind until they are put in application; but there is no reason to suppose that this process is ended. It is largely an economic question. When the need is sufficient and hundreds and thousands of minds are working on the problem, then it is only a limited time before some solution is found. We are already seeing the increasing substitution of cement for wood. It is already a commercial possibility to produce cement at such cost that for many purposes it is cheaper.

Hence, while we may sympathize most heartily with the objects of conservation and especially with the attempt to restrain speculative uses, I do not think it follows that there is any necessity of a needless panic. On the other hand, there has never been a time when there is so much reason for optimistic faith in the future or in the meeting of the problems as they arise. A failure in such faith is generally due to a lack of knowledge or of fundamental faith in a beneficent providence and a resultant feeling that the individual must shoulder the responsibility of thinking for the race.

Can it be that some of the pessimistic feeling that the country is extravagant in the use of its resources, is going to the dogs generally, is an evidence of the same tendency of men of middle age or past to believe that times do not compare with those of their youth in care, thrift, good qualities, virtue; a universal tendency and one which the Italian historian Ferrero, in a striking chapter, has assigned as the principal cause for the bad reputation which has come down to us of the Romans and their extravagance?

Many who have discussed the subject assume an attitude that most can not accept, and that is that saving is in itself an object, and therefore that to prevent or restrict use or put difficulties in the way with the object of preventing use is in itself commendable. Such a view is not infrequent, and especially among custodians, who come to look upon their positions of trust as ends instead of means; so that it is not infrequent to find librarians, for example, who feel that their duty is to preserve books and to be jealous of their use.

On the contrary, the highest use is use, and the best conservation is that which contributes to the increase of our comfort, happiness, or efficiency. This, however, should not sanction waste, but waste is always relative. Preservation may be as unnecessary as waste, and wanton preservation is worthy of condemnation as much as wanton waste. Conservation should not mean nonuse, but the highest use. It should be utilization rather than preservation, and the only justification which I can see in conservation, as often described, is that it may promote utilization. It should result in the lessening of waste. This, it should be remembered, is an economic question. There is always a balance of the opposing, conserving claims. One may be the conservation of the material, but, on the other hand, is the conservation of time or effort or energy, and this may be far more important than the material. This almost always comes back to the human element. Much is bound to be wasted and can not be otherwise. There is an increase in prevention of waste and the limit of waste is bound to vary at different times. At the point when the prevention of the waste of material may mean a waste of energy then is the point when it becomes economic loss to attempt to prevent further waste, or else it forces new processes and methods. We can not lose sight of the fact that it pays to waste and always will, though what this may be varies with the conditions and almost varies from day to day.

In the consideration of resources attention has been given almost entirely to two or three, and the fearful pictures made of these have been applied to other resources as well. There is, however, a distinction between the classes of these resources. Some, as coal, are consumed by the using, and when once used are gone, and therefore these would need more careful attention because their use

may mean the end of that particular resource, and we may be hampered unless new means of meeting the deficiency are discovered.

Such materials as iron or gold, on the contrary, are not consumed in the using, except to a small extent, and may be used over and over again almost indefinitely. Other natural resources, such as the growth from soil, are replaced in a moderate time.

The economic condition would lead in the case of coal to new substitutes or to the development of other sources of power. In the case of gold or iron or other metals, it might lead to the discovery of means of using present neglected resources, either by the discovery of new methods or by the increase in value which would justify the application of methods which are now economically impractical at the present prices. In the case of crops like forests, if substitution does not take place just so soon as there is a commercial benefit, or in other words when the price justifies the growth of the crop, then it will be taken up by hundreds of thousands of people as a definite, marketable crop.

Hence, while this discussion has caused much anxiety and should give serious thought to the persistence of our resources, it is not necessary to be alarmed.

Beyond these resources commonly mentioned we have others of far more importance which have greater value in the national wealth, which we have scarcely as yet touched, and which the work of this association tends to render more useful. Such are all the multifarious uses of the soil, the growth of the national wealth from this source. At no time have we understood so well how to retain the fertility and to maintain it in a high stage of production. We can find much to complain of, but still more for hope.

Another resource which has been almost untouched is water in agriculture. I do not mean water power, for that is relatively small. Our arid States have shown the value of water for irrigation, but only second to this is the correspondent value of water in a humid country where the rainfall is not distributed so as to be of the most value agriculturally. It can be used in New England as well as the Valley of the Willamette and the Snake, and the returns in central New York and Massachusetts might double the agricultural returns for large areas, irrespective of other considerations. This, again, is a question of whether it would pay.

And still the most important of our potential resources which I will only mention, and yet is proper at this association, is the youth of our own people. Whatever be our resources, whether they be as great as those of Africa or of Asia, they are of little value without an intelligent, energetic, and resourceful people. With them new resources will be discovered if necessary, their lack supplied. The cultivation of this resource is one of the objects of our body, and more important than any other single one.

In closing this imperfect presentation of one phase of this subject, and while some sides have not been mentioned, yet as a whole and in detail I can not share in the serious view so many of our current writers take of our immediate future. There are changes to take place, but we are wise in our own conceit to think that we know the bounds of our own world or our own limitations. The buffalo has gone, but in its place have come many times as many cattle and thousands of homes. Other supplies may end, but others will be found. At any rate I feel that while a careful outlook should be kept, as a nation and as a body we may accept the advice given to the young man hero in one of Longfellow's romances:

"Look not mournfully into the past, it comes not back again.

"Wisely improve the present. It is thine.

"Go forth to meet the future without fear and with a manly heart."

Report of Committee on Extension Work.

The report of this committee was presented by K. L. Butterfield, of Massachusetts, as follows:

I. SECTION ON EXTENSION WORK.

Your committee repeats its recommendation of a year ago, that there should be organized in this association a section on extension work. It is believed that such a section would accomplish the following results:

(1) It would at once elevate the extension work of the land-grant colleges to the place where it belongs—a line of endeavor coordinate with that of research through the experiment station and that of teaching through the college courses.

(2) It would immediately suggest to all the land-grant colleges the supreme desirability of organizing extension work in a way commensurate with its dignity and with the need for the work.

(3) It would bring into the ranks of this association the active managers of extension work, who have already formed an organization of their own. We need these men for the good of the colleges, for extension work can not safely be separated from the other work of our institutions.

Objections have been raised to the formation of such a section. Some of these are discussed briefly:

(1) Even if desirable, the time is not ripe for it.

It seems to the committee that we are fully ready for the organization of such a section, simply because the time is ripe for a complete recognition of this field of work and for its thorough organization. That this association is the proper body to take cognizance of these facts and to give the initiative to the movement admits of no debate, in our judgment.

(2) It would separate important discussions from the main program of the association.

Your committee believes that extension subjects are not likely to be discussed adequately in the main program of this association. It has many other things to discuss. Especially in the initial stages of extension work it is important that details be thrashed over and over again by the workers themselves in order that fundamental principles may be worked out from the chaff and eventually displace mere empiricism. We see no more reason why a section on extension work will result disastrously to our main program than is the case with other sections. It is not the function of your committee to outline methods of procedure for the annual meeting of this body, but we venture to suggest that sections designed respectively for the experiment station, for the college, and for extension work may well discuss the details of all problems which arise in the work and administration of those particular phases of our institutional work, and that the main program may well be reserved for the discussion of the larger implications of our field of thought and activity; in other words, for the study of agricultural education in its larger aspects, and for the consideration of the problem of coordinating these lines of work, and of relating them to the general movement for educational progress.

(3) It would raise the question of eligibility to membership in the association of managers of extension work.

The easiest solution of this difficulty is to make these men definitely eligible to the association.

II. NATIONAL APPROPRIATION FOR EXTENSION WORK.

Your committee also renews its recommendation of a year ago, in favor of a national appropriation for extension work, made under such conditions that state aid shall be absolutely requisite in order to secure any substantial amount from the federal treasury. Later in this report your committee will outline more fully its reason for this recommendation.

III. FRANKING PRIVILEGE.

The committee also renews its recommendation of a year ago for the granting by Congress of the franking privilege to bona fide extension publications.

IV. EXTENSION DEPARTMENT IN EACH COLLEGE.

Your committee has recommended for three successive years, and now repeats the recommendation, that there be organized in each land-grant college a thoroughly equipped plan for extension work. The colleges are gradually falling into line with this plan, but the movement is making slow progress.

We are more than ever impressed with the necessity of developing the thorough organization of the work and with the crying need for the work itself. Nearly every land-grant college is doing work of this character, but in most cases it is unorganized, chaotic, without large plan, and, as a rule, we venture to say, grossly inadequate to the needs of the working farmers of the respective States.

It has been suggested that your committee outline a practical plan by which this organization could be undertaken. Without going into any detail, your committee makes the following suggestions:

(1) That every land-grant college appoint a director of extension work who shall give all his time to this line of endeavor.

(2) That sufficient salary be paid to secure a man who is well equipped for the place, and that he be given substantial funds at the outset.

(3) That, whenever possible, he be given assistants, either one or more men who can give all of their time to extension work and act as "field agents," or have at his disposal the partial time of men who are connected with the college or station staff.

(4) That the first work to be done should be that of organizing those methods of extension work which are already in vogue at the college. Nearly all the colleges have large correspondence with farmers, send out publications which are in the nature of monographs on practical subjects, give lectures before granges and other local organizations, and hold demonstrations. We would advise that all of this work be unified and put, so far as the administration is concerned, into the hands of the director of extension work. It may be desirable temporarily to have even the short winter and summer courses offered by the institution placed under the same management, although, strictly speaking, these enterprises are not extension work. It is exceedingly important that men assigned chiefly to extension teaching, while immediately responsible to the director of that work, shall also have equally close connections with those teaching departments of the institution in which their special subject naturally lies.

(5) We would then go so far as to suggest that those activities of the experiment station which are not primarily connected with research or experimentation, but which are really designed to give popular dissemination to general agricultural information, and which so burden the time and energy of most of our station workers, should as rapidly as possible be given over to the general direction of the director of extension work.

(6) Finally, and most important of all, we would urge upon the director of extension work and the administration of the institution the prime necessity of getting into the public mind a thorough understanding of what exension work is. It is not a scheme to advertise the college. It is not a plan to trap students for the college, or even to get boys and girls interested in agricultural schools and colleges generally. It is fundamentally a means of teaching the people out of school about agriculture and country life in all its phases. It is an educational proposition. Its aim should be to reach every farmer and his family.

V. A CAMPAIGN FOR RURAL PROGRESS.

There is another phase of this movement for disseminating popular information about agriculture which has a very direct bearing upon the extension work of the agricultural college. It has become evident that while the work of our experiment stations, colleges, and farmers' institutes, in preaching the need of better methods of farming, and in seeking to discover and impress the great fundamental principles of agricultural production upon the people, is a work absolutely essential to agricultural progress, nevertheless we have heretofore placed the emphasis too exclusively upon the business of farming, and have not sufficiently emphasized the social or human aspect of the problem.

Furthermore, the various institutions engaged in work on behalf of our agricultural industry or rural people have labored very much by themselves. There has been a very slight measure of cooperation between rural church, country school, grange, club, agricultural college, and library.

There is now a clear thought that these two defects in our agricultural propaganda must be remedied. Without lessening in the slightest degree our efforts for more scientific farming, we must emphasize as never before the development of a better personal and community life in our agricultural districts and we must attempt in some way to bring together those various institutions and agencies designed to serve rural life which have hitherto worked apart.

A very suggestive pattern is found for this work in the new movement for "city planning." The idea of city planning originated with landscape gardeners and was designed for the beautification of our cities; but the movement has already grown far beyond any question of esthetics, and embraces a consideration of the whole range of moral and social life. It is exemplified in the

"Boston 1915" movement, which is attracting so much attention in the East, and which is nothing more nor less than a definite propaganda for the unification of all interests in that great city on behalf of a broad-gage campaign for urban progress, not only industrial and esthetic, but moral and social.

Now, the counterpart of this city planning may be expressed in the term "a campaign for rural progress." For several years this idea has been gaining ground in some States, and a number of conferences on rural progress have been organized. Three New England conferences on rural progress have been held in the city of Boston, and representatives from all of the New England States and their agricultural colleges and experiment stations, state granges, state boards of agriculture, state departments of education, state federations of churches, and other bodies have been present. There has been admitted to membership in this conference a list of about 70 institutions and organizations in New England, representing all possible phases of agriculture and rural life—technical, industrial, economic, educational, social, and religious. We have here, then, a type for a new movement in rural life, which is nothing more nor less than that of bringing to bear upon the development of the agricultural industry and the rural community the work of all those individuals and institutions that are concerned with the problem; and not only so, but of having withal a definite plan and goal for all this broad work.

Now, this idea of a campaign for rural progress is tied up intimately with the idea of the proper development of extension work in the land-grant colleges, because the function of extension work in a land-grant college is not only to impart knowledge, but also to give the college leadership in agriculture and country life. It seems to your committee as if the mention of these two great ideas—that American rural society is to plan its future, and that the agricultural college shall be the great organ of knowledge and leadership on behalf of this planning—suggests without further argument the prime importance of a great campaign for rural progress and the need of entering upon it at once.

VI. FEDERAL APPROPRIATIONS FOR EXTENSION WORK IN AGRICULTURE.

Your committee has already stated its recommendation for federal appropriations for extension work. In closing its report, your committee desires to outline with extreme brevity the character of legislation which it thinks desirable and the reasons for it. In the first place, we desire to mention a few general arguments for federal aid:

(1) It would stimulate the complete organization of extension work in our agricultural colleges.

(2) It would call attention to the importance of extension work, both in the college and among the people at large.

(3) It would give the movement a national character and significance. This is worth a good deal, because the work at once becomes a national concern, and not merely a question of state pride or efficiency.

(4) It would thus attract agricultural college students to the opportunity for a new career. Your committee believes that the proper development of extension work in our agricultural colleges means a new occupation for hundreds and perhaps thousands of well-trained men.

(5) Government supports a national system of agricultural colleges and experiment stations. This money, however, is not available for extension work, although extension work from our point of view is fully coordinate with the work of the college and station.

VII. A PLAN FOR A PROPOSED NATIONAL APPROPRIATION FOR EXTENSION WORK.

(1) Appropriate $10,000 a year from the National Treasury to each State and Territory, for extension work in agriculture and rural life.

(2) Provide that at any time, after two years have elapsed from the date any State or Territory has accepted this appropriation and has actually organized extension work in connection with its land-grant college, there shall be available from the National Treasury, in addition to the amount named above, an amount of money, for each State and Territory, for the same purpose, equal to the amount appropriated by the legislature of the State or Territory for this purpose; provided, that the additional appropriation to any State or Territory shall not exceed an amount equal to 1 cent per capita of the total population of that State or Territory as shown by the last United States census.

(3) This appropriation should be given specifically to the land-grant colleges and only to them.

(4) Require each college to organize a "department" or "division" or "school" of extension work, i. e., to organize the work as a definite part of the institution.

(5) Confine the work for the present to agriculture, domestic science, and other phases of rural life.

(6) Define extension work broadly and yet closely. Define agriculture and rural life so as to include instruction and aid in any phase of this field—in subjects technical and scientific, concerning business management, home making, sanitation; and economic, social, and moral subjects. Indicate that extension work is for adults and youth and children, and for people in towns and cities as well as in the open country.

(7) Extend the franking privilege to bona fide extension publications, and permit the use of the federal appropriations for printing such publications.

(8) Also appropriate annually a substantial sum, perhaps $25,000 to $50,000, to the United States Department of Agriculture for investigation into and experimentation with methods of popular education in agriculture and rural life, in this country and abroad, for distributing the results of such investigations, and for making demonstrations thereof.

ADVANTAGES OF THE PLAN PROPOSED.

(1) This plan would give the program for extension work immediate national significance.

(2) There would be no delay because of a failure of the legislature to act, and the work on at least a small scale could be started in each State.

(3) It provides sufficient money to put the poor, backward, or small State on a good footing with respect to the work.

(4) It enables the States to develop the work as rapidly as seems wise to them.

(5) It makes the United States Department of Agriculture a clearing house for methods of extension work, and keeps it in close touch with the work in all the States and Territories.

(6) It gives adequate breadth and scope to the whole scheme, and prevents States from leaving out important phases of the work.

(7) If later needs warrant, the per capita amount can be increased without other change in the law, and extension work in mechanic arts and in general culture subjects can be added by simple amendment.

(8) The amount of money immediately required is not large, and in fact when the act is in full operation will not draw heavily on either national or state treasuries.

(9) It divides the responsibility between national and state governments and completes the circle of national aid for the land-grant colleges on principles already recognized in the two Morrill acts, in the Nelson Act, in the Hatch Act, and in the Adams Act.

(10) It recognizes and supports the great movement for making more fully available to the mass of working farmers the results of the research and experimentation of the stations established under and fostered by the Hatch and Adams acts, and the organized teaching and inspiration of the agricultural colleges supported by the Morrill and Nelson acts.

VIEWS OF THE COMMISSION ON COUNTRY LIFE.

The position of your committee with respect to the development of extension work and the appropriation of federal funds to assist the States in carrying on this work finds substantial support in the report of the Commission on Country Life. This commission had unusual facilities for securing the opinion of the farmers of the country with respect to the chief needs of the time in the development of agricultural and rural life, as well as a unique opportunity to draw conclusions with respect to the fundamental principles of an advanced movement on behalf of American agriculture. We therefore desire to quote from that part of the report of the commission, as presented to the President, bearing upon the development of extension work on a national scale:

"We find a general demand for federal encouragement in educational propaganda to be in some way cooperative with the States. The people realize

that the incubus of ignorance and inertia is so heavy and so widespread as to constitute a national danger, and that it should be removed as rapidly as possible. It will be increasingly necessary for the national and the state governments to cooperate to bring about the results that are needed in agricultural and other industrial education.

"The consideration of the educational problem raises the greatest single question that has come before the commission, and which the commission has to place before the American people. Education has now come to have vastly more significance than the mere establishing and maintaining of schools. The education motive has been taken into all kinds of work with the people, directly in their homes and on their farms, and it reaches mature persons as well as youths. Beyond and behind all educational work there must be an aroused intelligent public sentiment; to make this sentiment is the most important work immediately before us. The whole country is alive with educational activity. While this activity may all be good, it nevertheless needs to be directed and correlated, and all the agencies should be more or less federated.

"The arousing of the people must be accomplished in terms of their daily lives or of their welfare. For the country people this means that it must be largely in terms of agriculture. Some of the colleges of agriculture are now doing this kind of work effectively, although on a pitiably small scale as compared with the needs. This is extension work, by which is meant all kinds of educational effort directly with the people, both old and young, at their homes and on their farms; it comprises all educational work that is conducted away from the institution and for those who can not go to schools and colleges. The best extension work now proceeding in this country—if measured by the effort to reach the people in their homes and on their own grounds—is that coming from some of the colleges of agriculture and the United States Department of Agriculture. Within the last five or ten years the colleges of agriculture have been able to attack the problem of rural life in a new way. This extension work includes such efforts as local agricultural surveys, demonstrations on farms, nature study, and other work in schools, boys' and girls' clubs of many kinds, crop organizations, redirection of rural societies, reading clubs, library extension, lectures, traveling schools, farmers' institutes, inspections of herds, barns, crops, orchards, and farms, publications of many kinds, and similar educational effort directly in the field.

"To accomplish these ends we suggest the establishment of a nation-wide extension work. The first, or original, work of the agricultural branches of the land-grant colleges was academic in the old sense; later there was added the great field of experiment and research; there now should be added the third coordinate branch, comprising extension work, without which no college of agriculture can adequately serve its State. It is to the extension department of these colleges, if properly conducted, that we must now look for the most effective rousing of the people on the land."

Respectfully submitted.

KENYON L. BUTTERFIELD,
C. R. VAN HISE,
W. C. LATTA,
C. F. CURTISS,
ANDREW M. SOULE,
W. M. HAYS,
Committee.

The recommendations contained in the report were referred to the section on college work and administration for consideration. Later the section reported its approval of the report with the understanding that only the general idea of a federal appropriation was considered, and the report was adopted.

For further action, see pages 45, 46.

STATUS OF THE SEPARATE LAND-GRANT COLLEGES.

Howard Edwards, of Rhode Island, introduced certain resolutions emanating from the section on college work and administration and relating to the status of the independent land-grant colleges, which were referred to the executive committee under the rules. See page 43 for action on this matter.

Report of Committee on Instruction in Agriculture.

The chairman of this committee, A. C. True, presented the following report:

Since the Washington meeting of this association in November, 1908, subcommittees have been engaged in preparing a four-year course in home economics and a one-year course in animal husbandry and dairying for secondary schools. The subcommittee on home economics, consisting of H. T. French and H. C. White, with the aid of a college teacher of home economics, has prepared an outline four-year course in home economics.

The subcommittee on animal husbandry and dairying for secondary schools, consisting of T. F. Hunt and A. C. True, engaged Prof. H. R. Smith, of the Nebraska College and School of Agriculture, who has prepared a series of lecture outlines, recitations, and practicums, concerning types and breeds of farm animals (horses, cattle, sheep, goats, swine, and poultry), the care and feeding of animals, milk and its products. This course is intended to be used in connection with text-books and bulletins to which numerous definite references are given.

The committee proposes to edit these two courses and publish them in confidential form in order to get criticisms and suggestions from numerous teachers, as was done in the case of a secondary course in agronomy, which has been published as Circular 77 of the Office of Experiment Stations.

The committee has also given some preliminary consideration to courses for the preparation of teachers of agriculture, with special reference to the work of agricultural colleges in this line, but is not prepared to report definitely on this subject at present.

A. C. True,
T. F. Hunt,
H. T. French,
H. C. White,
J. F. Duggar,
W. E. Stone,
Committee.

The report was accepted.

Report of Committee on History of Agricultural Education.

A. C. True, chairman, presented the report of the special committee on this subject as follows:

I might state in a preliminary way that some time ago a special committee was appointed, consisting of Dean Davenport, Dean Henry, and myself, to gather documents and other data regarding the history of agricultural education. That committee has been at work along that line since that time.

Under the general arrangement made by the committee and approved by the association, the Office of Experiment Stations is the depository for documents and we already have a considerable collection. This report covers the work of the committee since the Washington convention.

As a result of the inquiry started in 1908 by the committee on the history of agricultural education several valuable historical documents have been received this year by the Office of Experiment Stations. Among these is an article by Paul Selby, of Chicago on "The Part of Illinois in the National Educational Movement, 1851–1862," and several papers from W. H. Brewer, of New Haven, including a copy of the prospectus of Oakwood Institute, which was opened at Lancaster, N. Y., in April, 1851, "for the reception of pupils of the age of 12 years and upwards," who "will be carefully instructed in agricultural chemistry, the analysis of soils, etc., by a pupil of Mr. Norton, professor of scientific agriculture in Yale College." The school also announced a course of instruction especially designed for practical farmers and young men from the country, to commence about the 1st of January and continue three months. This apparently was one of the earliest announcements of a short winter course for farmers, but the course was never given. A fire which destroyed the property of two of the chief promoters of the school caused it to be closed just before the short course was announced to begin. Professor Brewer has also contributed a copy of a manuscript prepared by him some time between 1888 and 1892 on "The Intent of the Morrill land grant."

The committee has also received an important manuscript from J. N. Hook, of South Carolina, this being a statement dictated by Senator B. R. Tillman

setting forth his connection with the struggle (1885–1890) for the establishment of a separate agricultural and mechanical college at Clemson.

Through the kindness of F. W. Howe in preparing a manuscript of 48 typewritten pages, the committee has been able to secure considerable historical data from the earlier reports of the Michigan State Agricultural Society and other publications concerning the agitation for the establishment of the Michigan Agricultural College, as well as earlier movements for including instruction in agriculture in the courses of study offered by the Michigan Normal School at Ypsilanti and the Michigan State University at Ann Arbor.

It appears from this manuscript that as early as 1849 the state legislature in Michigan instructed its "delegation in Congress to use all honorable means to procure a donation of 350,000 acres of land for the establishment of agricultural schools in the State," and Mr. Howe raises the question whether this action does not take priority over any other official action to secure a national land grant for the purposes of agricultural education. It is also shown from a letter written by the state superintendent of public instruction in 1852 to the secretary of the State Agricultural Society that the State Normal School at Ypsilanti, which was dedicated October 5, 1852 offered courses of "instruction in the mechanic arts, the arts of husbandry, and in agricultural chemistry," and from a letter written by the chancellor of the State University to the secretary of the State Agriculural Society that the university had organized in 1852 "an agricultural school as a part of the scientific course recently adopted by the faculty and regents," in which lectures were to be given during the spring and summer terms (1853) on the following subjects:

(1) Daily lectures on chemistry (elementary and experimental), chemistry applied to the arts, meteorology, and climate.

(2) Geology and mineralogy, and the application of the same to mining, drainage, construction of public works, etc., illustrated by specimens from Michigan, the neighboring States, and foreign lands; also models and drawings.

(3) Animal and vegetable anatomy and physiology in general, the physiology and diseases of domestic animals in particular, and the structure and habits of insects in reference to grain, trees, and horticultural plants.

(4) Organic chemistry and the theory and practice of agriculture, the origin and nature of the soils, the different varieties of manure, tillage, tools, etc.

The first professor of agriculture in the State University was the Rev. Charles Fox, rector of the Episcopal Church at Grosse Isle, near Detroit, who had been senior editor of the Farmer's Companion and Horticultural Gazette, and later, in 1854, published a "Text-book of Agriculture," which was the first agricultural text-book published west of the State of New York.

Mr. Howe's manuscript goes somewhat into the details of the struggles in Michigan for and against the establishment of the agricultural college separate from the State University; calls attention to the admission of young women students to the college in 1870, who "prepared seed for the ground, cut potatoes, transplanted tomatoes and flowering plants, pruned shrubbery, gathered small fruit, did some work in the greenhouse, and many other kinds of work;" and gives references to records dealing with the early efforts of W. C. Flagg, secretary of the board of trustees of the Illinois Industrial University, and Dr. Manley Miles, professor of agriculture in the Michigan Agricultural College, for the establishment of a society which was the forerunner of the Association of American Agricultural Colleges and Experiment Stations. Ninety-eight pages of the report of the Michigan State Agricultural Society for 1871 are given to the discussions had in the first meeting of this society, held in Chicago, August 24, 1871, which were participated in by such men as Doctor Miles, Professor Swallow, Prof. John Hamilton, Professor Gilman (then of the Sheffield Scientific School, later president of Johns Hopkins University), President Welch, President Denison, Professor Hilgard, and others.

These manuscripts and documents which the friends of agricultural education have so kindly donated to the committee will be of inestimable value when an opportunity is afforded for compiling a history of agricultural education in the United States.

A. C. TRUE.
E. DAVENPORT.
W. A. HENRY.

The report was received and ordered made a part of the proceedings, and the committee was continued.

The association adjourned to meet at 8 o'clock p. m.

Evening Session, Thursday, August 19, 1909.

Vice-President Kerr called the meeting to order at 8 o'clock p. m.

Report of Committee on Affiliation.

This report was presented by the chairman of the committee, H. J. Waters, of Kansas:

Your committee appointed to consider the advisability of a closer affiliation between the various societies and organizations seeking to promote the science of agriculture and to report on the relation that the Association of American Agricultural Colleges and Experiment Stations should sustain to such a federated organization begs leave to submit the following report:

(1) It is the opinion of your committee that the interests of agricultural education and research will be more effectively promoted by the more complete correlation of these various societies than exists at present, and that this association may very appropriately lend its encouragement to its accomplishment.

(2) While it is our opinion that this association can not sustain a direct and vital relation to this proposed federated organization, it is recommended that the association give its indorsement to the resolution adopted by the Society for the Promotion of Agricultural Science at its annual meeting, held in Portland, August 17, 1909, which is as follows:

"Recognizing the advantages of closer cooperation in the various lines of scientific agriculture, the Society for the Promotion of Agricultural Science hereby extends a cordial invitation to American Forestry Association, Society of American Foresters, Official Dairy Instruction Association, American Association of Economic Entomologists, Association of Official Agricultural Chemists, Society of Horticultural Science, American Breeders' Association, American Society of Agronomy, the American Society of Agricultural Engineers, Society of Animal Nutrition (and any others that may be in existence), and other similar organizations to unite with it in the formation of an affiliated society which shall include all these organizations which are working for the promotion of scientific agriculture. It is suggested that the affiliation may be formed upon a basis somewhat as follows:

"(1) Each society shall retain its individual organization and shall have entire control of its own business, including election of members and publication of proceedings. If found feasible, however, a common secretary may be employed for the editing and publishing of the several reports.

"(2) There shall be a council composed of one or more representatives from each affiliated society, which may elect an executive committee from among its own members.

"(3) The affiliated societies will hold affiliated meetings on alternate years at the same place, and at nearly the same time as the meeting of the Association of American Agricultural Colleges and Experiment Stations, and for such meetings the council shall prepare a general program in which papers of general interest shall be presented to the joint meetings of the societies, while other papers shall be referred to the affiliated society to which it will be of the greatest interest. On the alternate years, when no joint sessions are held, each of the affiliating societies will hold meetings at such times and places as its own members may decide.

"(4) The council shall publish annually a report of its proceedings and of the proceedings of the general meeting. It may also publish any or all of the papers presented at the general meeting, and any other matter directly related to the promotion of agricultural science which it may deem expedient: provided, however, that this shall not operate to prevent the publication of papers also in the proceedings or journals of the individual societies.

"(5) Each society shall pay to the treasurer of the council annually a pro rata sum for each of its members (not including honorary members), the amount of which shall be fixed annually by the council. Payments from the funds of the affiliated societies shall be made only on the order of the council or of its executive committee.

"In order to carry out this proposed affiliation the secretary of the Society for the Promotion of Agricultural Science is directed to forward a copy of this to each of the societies named and to request the appointment of three delegates from each, if such have not already been appointed, to meet with

the executive committee of this society to consider the desirability of the proposed affiliation, and to arrange a satisfactory plan for its accomplishment. It is requested that these delegates be given power to act for their respective organizations, and it is understood that the outline proposed above may be changed or modified as may be wished by a majority of the delegates present at the proposed meeting.

"It is requested that the delegates meet at the same place and on the day preceding the next meeting of the Association of American Agricultural Colleges and Experiment Stations for the consideration of this matter."

(3) In furtherance of this plan it is recommended that this association invite these allied societies to meet on the day preceding the beginning of the convention of this association.

(4) Concerning the matter of the publication of the scientific work of the experiment station in cooperation with these societies, it is deemed inadvisable to pursue the matter further until it can be definitely ascertained whether or not the plan can be carried out which has already been presented to this association by the committee on experiment station organization policy.

Very respectfully submitted.

(Signed) H. J. Waters,
T. F. Hunt,
H. J. Wheeler,
Committee.

The recommendations contained in the report were referred to the executive committee. For further action, see page 45.

Work of the Country Life Commission.

By special request, L. H. Bailey, of New York, addressed the association at this time on the work of the Country Life Commission.

A resolution regarding the work of the Country Life Commission, approved by the college section, was offered by J. A. MacLean, of Idaho, and was referred to the executive committee (see pp. 44, 99).

The convention adjourned to meet at 10 o'clock Friday morning, August 20.

Morning Session, Friday, August 20, 1909.

The meeting was called to order at 10 a. m. by Vice-President Kerr.

Status of Separate Land-Grant Colleges.

Howard Edwards, of Rhode Island. I am not a stickler for terms. I simply want to get at the facts. In preparing the resolution which is before us I had in mind the statement of the status of the separate land-grant colleges more particularly. I think, perhaps, it is not realized that in the East we have a somewhat different situation from that which exists in the West, and as a result of that situation some such statement has come to be what we need quite urgently to-day in order to unify sentiment among ourselves with regard to the separate land-grant colleges. Various expressions have been made with regard to the separate land-grant college which have been used to our disadvantage. Perhaps the expressions were not intended for that purpose. I do not think they were, but they have been used.

There are two points on which strong agitation is being carried on in some quarters. As I stated yesterday, the first point is an effort to make the separate land-grant college practically identical with the agricultural high school. The second is an effort to define mechanic arts, a term that belongs to a past generation, a term which has no very definite meaning for the present generation.

In 1862, when the first Morrill Act was passed, engineering had no very distinct development in this country. Civil engineering was practically all that was known of engineering. Since that time engineering has developed to

include all the industries that pertain to the handling of machinery or the direction of physical forces for the purpose of satisfying human wants. Now, the Morrill Act was intended for the purpose of meeting the needs of two—not one, but two—great classes of our people, and it seemed to me that the time was ripe for the association as such to define its position with regard to the meaning of the term "mechanic arts." As I said in the beginning, I am not a stickler for terms—for words. Naturally I prefer my own words in expressing my own meaning, but the executive committee, as I understand it, has reworded this matter to suit themselves and it has been submitted to me. I have gone over it quite carefully. I think it covers the three points that I wanted to make, although it is not as detailed and specific as I should desire. I therefore offer as a substitute for the resolution that I put in the following resolution which the executive committee has prepared:

Resolved, That it is the sense of this association that the national laws which constitute the charter of the land-grant colleges distinctly prescribe work of collegiate grade in agriculture and the mechanic arts, including engineering in all its branches, and the sciences related to the industries, irrespective of whether the colleges are established separately or as parts of universities.

Just one more word with regard to the resolution. The movement to consolidate and unify in education is in a general way correct, but I have no apology to make for the existence of the separate land-grant college, concerning which it was stated yesterday by a personal friend of mine, a man whom I esteem very highly indeed, that if the present psychological atmosphere had prevailed from 1862 on it would have been far better if all the schools founded on land-grant funds had been united in one effort by the State for higher education. I am not prepared to take that view, but I want to say that, whatever might have been better, the present situation exists. The land-grant college has done a great work in creating an intellectual atmosphere. It has done it also independently of the university idea, and had it not been for the existence of the separate land-grant college we would not be where we are to-day in respect to this atmosphere. Further than that I desire to say that this function of creating an atmosphere in given sections has not been entirely completed. I know whereof I speak when I say that the separate land-grant college is a vital influence in certain sections in directing, elevating, and clarifying views in regard to industrial education, and we have no right to minimize the importance of the separate land-grant college. I do not have any apology to make for it.

I submit the resolution as an action designed on the part of this association to unify in their aim and purpose all institutions that have to do wth industrial education, so far as the land-grant fund is concerned.

Work of the Country Life Commission.

The executive committee reported back to the convention the following resolution presented by J. A. MacLean, of Idaho:

Resolved, That this association express its appreciation of the work of the Country Life Commission in its preliminary analysis of existing rural conditions; and in the belief that the point of view represented by this commission is important and should be more fully developed,

Resolved, That the executive committee of this association be authorized and instructed to memorialize the President and Congress (1) for the general distribution of the report of the Commission on Country Life, (2) for some provision by Congress for digesting and utilizing the great mass of material and information collected by the commission, and (3) for provision by Congress for a broad and systematic inquiry of extended character into the economic, social, and educational conditions that affect rural life.

The resolution was adopted.

Report of Committee on Affiliation.

W. E. Stone, of Indiana. The question was raised on the recommendation of the committee on affiliation that the association invite these allied societies to meet on Tuesday preceding the main meeting of the convention of this association, which should be called for Wednesday instead of Tuesday as heretofore. The executive committee thought it would be better not to specify the days of meetings of the association or these societies, as called for by this recommendation, preferring rather that the action might be that the association invite these allied societies to meet on the day preceding the beginning of the convention of this association, having in mind, of course, to make preliminary provision for the assembling of these societies.

The recommendation of the executive committee and the report as a whole were adopted.

Recommendations of the Executive Committee.

The committee appointed by the chair to consider the recommendations contained in the report of the executive committee reported as follows:

Your committee, to whom were referred the suggestions of the executive committee, begs leave to report as follows:

That the representation of the interests of this body before the Carnegie Board shall rest with the executive committee itself, with the understanding that it may secure any and all assistance necessary to the adequate representation of the varied interests involved.

This recommendation is no reflection upon either the ability or the faithfulness of any individual, but at least four classes of institutions are involved in this matter, viz, the college that is connected with a university, the college that is distinct, the station that is connected with a college, and the station that is distinct.

The composition of the executive committee is usually favorable to the representation of all these interests far more adequately than they could be represented by any individual, with the added prestige that goes with its position as representative of this body.

Your committee further recommends that the executive committee be authorized and instructed to secure the publication in full of the proceedings of this association, omitting only irrelevant discussions and extraneous matter; and that for this purpose the proceedings shall be edited and prepared for publication by the secretary of the association.

In case it is necessary to publish at the expense of the association the bills shall be audited and paid in the usual manner.

Respectfully submitted.

E. Davenport,
A. B. Storms,
E. A. Bryan,
Committee.

The report was adopted.

Amendment of the Constitution.

The question of amending the constitution to provide for a section on extension work was taken up. The proposed amendment reported from the last convention of the association was as follows:

At the end of paragraph 1, under the head of "Sections," add the following clause: "A section on extension work composed of directors or superintendents of extension departments in the institutions in this association, or the representatives of such departments duly and specifically accredited to this section."

On a call of the roll of delegates by the secretary 42 voted aye and 9 nay, and the amendment was declared adopted.

The executive committee was authorized to make such verbal changes in the constitution as might be rendered necessary by the adoption of the amendment.

EXTENSION WORK.

K. L. BUTTERFIELD. The committee on extension work wishes to request that the officers who are nominated by the association for the section on extension work be authorized to prepare a program for the section at the next meeting of this association, and the committee in order to bring the matter definitely before the association would recommend, or suggest, perhaps, that the chairman of this section for this year be A. M. Soule, of Georgia, and the secretary, G. I. Christie, of Indiana.

The recommendation was adopted.

W. H. Jordan, of New York, urged more prompt attention on the part of officers of the sections to the preparation of their programs for the next meetings.

RESOLUTIONS OF THANKS.

Resolutions of appreciation and thanks to various agencies that contributed to the success of the Portland meeting, including the Oregon Agricultural College, the Portland Commercial Club, and the citizens of Oregon generally, were adopted.

CONSERVATION OF NATURAL RESOURCES.

The report of the committee on this subject being called for, J. L. Snyder, of Michigan, chairman of the committee, said that there was no formal report to make.

The committee was continued.

ELECTION OF OFFICERS.

The following officers were chosen for the ensuing year: President, W. J. Kerr, of Oregon. Vice-presidents—first, H. J. Waters, of Kansas; second, W. P. Brooks, of Massachusetts; third, C. A. Lory, of Colorado; fourth, P. H. Rolfs of Florida; fifth, L. Foster, of New Mexico. Secretary and treasurer, J. L. Hills, of Vermont. Bibliographer, A. C. True, of Washington, D. C. Members of the executive committee—from the section on college work and administration, W. O. Thompson, of Ohio; J. L. Snyder, of Michigan; W. E. Stone, of Indiana; from the section on station work, W. H. Jordan, of New York; C. F. Curtiss, of Iowa.

The following nominees for officers of the sections were confirmed: College section—chairman, S. Avery, of Nebraska; secretary, W. D. Gibbs, of New Hampshire; program committee, the chairman and secretary of the section. Station section—chairman, F. B. Linfield, of Montana; secretary, H. L. Russell, of Wisconsin; program committee, the chairman and secretary of the section and W. H. Beal, of Washington, D. C. Section on extension work—chairman, A. M. Soule, of Georgia; secretary, G. I. Christie, of Indiana.

The following appointments on the standing committees were made:

Committee on instruction in agriculture: J. F. Duggar, of Alabama, and W. E. Stone, of Indiana.

Committee on graduate study: W. O. Thompson, of Ohio, and Brown Ayres, of Tennessee.

Committee on extension work: A. M. Soule, of Georgia, and E. A. Burnett, of Nebraska.

Committee on experiment station organization and policy: M. A. Scovell, of Kentucky, and L. G. Carpenter, of Colorado.

The chair explained that Director Thorne had specially requested that he be not reappointed upon the committee on station organization and policy.

Report of Committee on Station Organization and Policy.

The following report was presented by E. Davenport, chairman:

The committee on station organization and policy has continuously studied the more salient features of station work and in each of its reports has dealt with some one phase of the subject. For three years it has been collecting data as to the methods of dissemination of the results of station investigation. While your committee have other subjects under consideration, this report is confined to recommendations relative to means of publicity.

This report is presented in two sections, one having reference primarily to publications by the stations themselves; the other to a common medium of publishing the results of station research work. The recommendations covering the station publications are made in the interest of uniformity. An extensive study of these publications betrayed a variety in form, serial number, and pagination confusing beyond expression to the would-be student and collector. The new departure in a common medium for publishing the results of station research work is recommended after a painstaking study extending over eighteen months, in which the attempt was made to obtain the ideas and wishes of the members of this association. The outline proposed has been discussed in and indorsed by both the college and station sections of this association.

MEANS OF DISSEMINATING STATION WORK.

In the Hatch and Adams acts provision was made for the acquisition of agricultural information by means of research, also in the Hatch Act for the publication of the results of such research in station bulletins, but in many of the States a large proportion of the farmers either do not receive the bulletins or they are unable to profit by them as they should. In view of this fact every legitimate effort should be made to aid the agricultural press in presenting the station work to the people at large in a popular form. To this end abstracts of bulletins should be furnished to the press, and also illustrative material by way of cuts, charts, etc.

It is recommended that greater attention be given to the organization of departments of cooperative experimentation under such a system that the station shall oversee all of the important features of the work, such, for example, as the inauguration of experiments in the field and the harvesting and weighing of the crops.

It is further recommended that the stations lend their sympathetic support to the organization of demonstration unions, which shall have for their purpose the exploitation by the members of the station work worthy of general application.

On account of the fact that the station investigator has little time for institute work it should be his province to teach the agricultural teacher rather than the public, though it is desirable that he should occasionally attend institutes. That this may be successfully done it is recommended that short normal courses be held at the colleges or independent stations prior to the beginning of the institute season, and that the stations should cooperate in this work by way of setting forth its results and, when desirable, provide illustrative material.

STATION PUBLICATIONS.

The publications of the stations termed "bulletins" should contain solely the results of research, the financial statement, and a general description of the work. They should be paged continuously throughout a given volume, and should be arranged in volumes of convenient size for binding. Each volume should have a table of contents, a title page, complete index, and accompanying directions for binding. The table of contents, title page, and index should be so printed that they can be easily removed and placed in proper position without cutting to single pages.

All publications dealing with inspection work of whatever kind should be published under a series known as "official inspections." These should be numbered consecutively, regardless of the order of sequence of the inspection work; for example: Fertilizers, No. 1; feeds, No. 2; fertilizers, No. 3; human foods, No. 4; and orchards, No. 5.

Such publications may or may not be paged consecutively, since the material is usually only of transient value.

The annual report, if merely embracing the financial statements and a brief summary of the work of the year, should be issued as a "bulletin." If it is of large size and is made a repository of matter of permanent value, it should have its own table of contents, title page, and index.

All other matter published by the stations should be classed as "miscellaneous publications." This may include circulars, notes to the press, etc. Such matter need not be prepared with reference to preservation in indexed volumes. Bulletins of such character as not to be of interest to the general farmer should be numbered and paged consecutively with the others, but should be issued only in limited editions, chiefly to libraries and scientific workers. Popular abstracts of all such bulletins should be prepared, showing the pages represented by the complete bulletin, thus indicating to all who wish to bind them that a complete copy should be secured to take the place of the one in abstract.

All bulletins and reports should have the number and date of the publication at the top of the left-hand page and a running title at the top of the page at the right.

The name of the station, the number of the bulletin, and the title should appear conspicuously and, uniformly for a given station, in the same place on the title page.

All bulletins should be electrotyped, if possible, in order that later demands for them may be satisfied.

Each station should set apart a sufficient reserve of each bulletin to meet demands for several years from important libraries and from kindred institutions, to the end that such institutions may be able to make their bound sets complete.

Each bulletin and each article in reports should, when practical, contain a brief, concise summary.

The stations should adopt the same abbreviations in referring to other publications as are used in the Experiment Station Record.

RESEARCH JOURNAL FOR EXPERIMENT STATIONS.

A journal of agricultural research with uniform size of page to contain detailed original reports of scientific investigation made by the agricultural experiment stations.

This journal to be published by the United States Department of Agriculture under the terms of a cooperative arrangement between the Secretary of Agriculture and the Association of American Agricultural Colleges and Experiment Stations.

The use of this journal will not preclude the publication of the same material by the individual station.

The journal to be prepared under the general management of an editorial board appointed jointly by the Association of American Agricultural Colleges and Experiment Stations and the Secretary of Agriculture.

The Director of the Office of Experiment Stations to be ex officio secretary of the board.

Editorial office to be in the Office of Experiment Stations.

Cost of publication to be defrayed by Congress.

Free distribution to be restricted to lists to be prepared under the supervision of the editorial board.

Price lists to be regularly sent to lists of individuals and institutions at home and abroad prepared under the supervision of editorial board.

The Department of Agriculture to be in nowise held responsible for articles published in this journal.

The executive committee of the association are, by the adoption of this report, instructed to confer with the Honorable Secretary of Agriculture, and to take such steps and use such means as shall in their judgment lead to the establishment of a medium of publication for station research on the general principles herein outlined.

E. Davenport.
H. J. Wheeler.
Chas. D. Woods.
Chas. E. Thorne.

The report was adopted.

Annual Dues.

It was voted that the assessment for the coming year be $15 for each college and station represented in the association, but that in the event it became necessary for the association to meet the expense of printing the proceedings of the association then the assessment should be $25 for each college and station.

Funds for the Graduate School.

E. Davenport. While we are considering financial affairs it may be proper to say a word about our graduate school fund. The auditing committee in looking over the treasurer's books was reminded of the fact that only 22 institutions have subscribed to the graduate fund. This is a serious situation. I speak of it from the standpoint of a member of the committee on graduate study and of one who has had something to do with the expenses of these schools in the past.

We have had some difficulty so far in finding institutions willing to entertain this graduate school, and I am sure others will agree with me in saying that this entertainment is no small burden upon an institution. It goes without saying that the supply of institutions willing to invite the school which the association has adopted or developed and which it only partially supports in money is going to be uncertain. Legal difficulties are cited, but in general either 22 colleges are acting illegally or 22 other institutions are too much scared about the law. This matter of $25 per institution per year for this purpose is a simple matter. I can not see where it would be illegal in any case. I can not believe that out of our 50 colleges and institutions in this country only 22 can help to support this school.

A. C. True. I heartily agree with what Dean Davenport has said, and in that connection it must be kept in mind that the money contribution of the holding institution is only a small part of its actual contribution, because the institution gives the use of its buildings, laboratories, equipment, and the services of a considerable number of its faculty to the graduate school, so in the total it is a very large contribution that the holding institution has to supply. It seems to me that the other institutions represented in the association should show their sense of gratitude toward the holding institutions by a general cooperation in the work of the school. I can hardly believe, whatever the legal status may be, that any institution represented in this association can not secure $25 a year from some source which may be devoted to the purpose of graduate schools. It only needs a little attention on the part of the managers of these institutions to secure more general cooperation in the work of the schools.

It is also very desirable that some arrangement should be made within each agricultural college by which members of the faculty and station workers may have opportunity to attend this graduate school. The membership has steadily risen, but so far it has not reached the point it ought to, provided there was general participation in the school by all the institutions.

I recognize the fact that the labors of the faculties of these institutions are constantly increasing and particularly that the establishment of summer sessions has made it difficult for men to attend the graduate school. But I feel sure that if all the institutions have clearly in mind the advantages of the graduate school they can arrange so that some members of their faculties in every case will be able to attend its sessions.

The association then adjourned sine die.

MINUTES OF THE SECTIONS.

SECTION ON COLLEGE WORK AND ADMINISTRATION.

Afternoon Session, Wednesday, August 18, 1909.

The meeting was called to order at 2 o'clock p. m., by W. J. Kerr, of Oregon, secretary.

In the absence of the chairman, J. C. Hardy, of Mississippi, was chosen to preside.

The following paper was read by A. B. Storms, of Iowa:

The Distinctive Work of the Land-Grant Colleges: Their Function, Scope, and Organization.

The "land-grant college" has now been in existence long enough to make the inquiry as to what definition it has wrought out for itself both pertinent and interesting.

It was obviously the intention of Congress, which out of its wealth in lands appropriated endowment for the purposes expressed in the Morrill Act, that institutions of learning should be organized entirely distinct from existing state universities. It was an after thought in several States that this endowment might be turned over to the state universities on condition that the universities should incorporate into their curricula the subjects required in the Morrill Act.

The argument for thus centralizing the educational resources of any State in one institution is familiar. This argument was used effectively by President Andrew D. White in the case of Cornell University. And this policy of centralization has been followed in a number of other States than New York, though I believe in New York an institution separate from Cornell has now been authorized. Wisconsin, Illinois, Nebraska, and Minnesota are notable instances of this centralizing policy.

The reasons for consolidation may be summarized briefly as economic and pedagogical.

It would appear to be more economical to administer the interests of a college of agriculture and mechanic arts as part of a greater university than as a separate institution. Pedagogically the idea has been a fascinating one that a university should be a place of learning where anybody could get anything. As nearly as possible it has been felt that a university should, as its name implies, be hospitable to all learning. In America particularly there has been a very eager ambition for bigness, and it has been considered that resources, scope and variety of work, and numerical enrollment of students were tests of greatness.

In all candor, has not the time come for frank and critical inquiry into the validity of some of these current ideas?

It has so long gone almost without challenge that those States were somehow actuated by a narrow and shortsighted policy that organized their colleges of agriculture and mechanic arts separately from state universities that it may seem startling and revolutionary to suggest the possibility that such separate organization is first of all in the spirit and intent of the original land-grant act, and, second, that such separate organization is pedagogically the wiser policy.

These are suggestions, however, which I wish to make at this time.

Our "Magna Charta" reads in part, "and the interest of which shall be inviolably appropriated, by each State which may take and claim the benefit of this act, to the endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

In Iowa, which may be taken as typical, the general assembly, September 11, 1862, accepted the grant upon the conditions and under the restrictions contained in the act of Congress, and by so doing entered into contract with the General Government to erect and keep in repair all buildings necessary for the use of the college. By this act of the general assembly the college was changed from an agricultural institution into a college of agriculture and mechanical arts, with the broad and liberal course of study outlined in the following paragraph.

In 1882 the general assembly passed an act defining the course of study to be pursued as follows:

"SECTION 1. That section 1621 of the Code is hereby repealed and the following is enacted in lieu thereof: 'Section 1621. There shall be adopted and taught in the State Agricultural College a broad, liberal and practical course of study, in which the leading branches of learning shall relate to agriculture and the mechanic arts, and which shall also embrace such other branches of learning as will most practically and liberally educate the agricultural and industrial classes in the several pursuits and professions of life including military tactics.'"

Universities were more eager to enjoy the benefits of the endowment than to carry out its purpose, though it should in justice be said that now some university authorities are earnestly seeking the development of this phase of their work and with commendable success.

At first, however, the presence of older and more definitely established courses of study and professional schools overshadowed the newer interests. Especially has this been true in agricultural science. Schools of agriculture have been organized in connection with universities that were purely secondary in grade, or the courses in agriculture have been established with practically no entrance requirements, or with low entrance requirements. In some States the energies of the faculties in agriculture have been devoted to short courses of a few weeks or a few months rather than to thoroughly collegiate courses leading to degrees and based on a thorough study of the natural sciences.

On the whole it seems to have been easier to develop courses of scientific character and collegiate grade and to command student enrollment in considerable numbers for such courses where the institutions have been organized separately from State universities. Cornell is a notable exception, and in Minnesota, Nebraska, and Wisconsin there are courses of collegiate grade enlisting increasing numbers of students. However, the university colleges of agriculture have followed somewhat tardily in this development.

There is a pedagogical reason for separate organization—perhaps it should be called an administrative reason—which has received but little, if any, adequate consideration. The rapid evolution of courses of study in the fields of applied science has resulted in a variety and extent of work sufficient for any one administrative head or governing body. A well-equipped college of agriculture and mechanic arts to-day will offer five or six hundred distinct courses of study, will have a hundred laboratories, and faculties numbering one hundred and fifty or two hundred. It will have resources equivalent to an endowment of fifteen or twenty millions of dollars and will be organized into twenty or thirty distinct departments. Its student enrollment will be from fifteen hundred to two thousand or more. This is vastly more in variety and interest than any university included but a few years ago, and is enough for one institution.

The department-store idea is going out of date. The great historic institutions of learning, prototypes of the modern university and the modern college, grew up around a central and single idea. The University of Athens sprung from the philosophical impulse of Socrates, Plato, Aristotle. The University of Alexandria grew up around a library and the passion for manuscript.

The University of Bologna was a school of law, the University at Salerno was a school of medicine, the University of Paris, prototype of modern universities,

sprang from the philosophical impulse of Abelard and was essentially a school of philosophy in the period of conflict between nominalism and realism. Indeed, as President Schurman of Cornell has frankly said, "The notion that a university is a school in which all the faculties or branches of knowledge are represented has no warrant in history."

The astonishing complexity and variety and diversity of work now done in institutions of higher learning leads to many perplexing administrative problems.

Is there not in the fundamental idea of the land-grant college—namely emphasis upon science as related to the industries—a unifying and coordinating influence that makes for sympathy and cooperation hard to secure among colleges that lack such coherence? The American university is in danger of becoming unwieldy.

It seems logical therefore to consider that the typical land-grant college is the separately organized college rather than those organized with universities.

At first these institutions, though inspired with a great and fruitful idea and with a desire to make higher and scientific and technical education democratic and to bring its privileges near to all the people, had, nevertheless, to feel their way toward a definition of their purpose and to work out suitable courses of study. This task becomes one of deepest interest and fraught with not a few difficulties because the whole field of applied science is new. In agriculture particularly a knowledge of scientific principles and their application to the problems of animal husbandry and of the soil, of dairying and of horticulture, was quite imperfect, but has rapidly increased in definiteness, scientific accuracy, and industrial importance. The progress of the last forty years, whether measured by bulk or quality, is probably more significant and more important than that of all the preceding centuries.

The task of defining the field of science and applied science in college courses also presented educational problems of the gravest importance. If, in accordance with the national and state law, the youth who were to attend these institutions were to be broadly and liberally educated, and at the same time to be technically trained in science as related to the industries, a double purpose of most critical importance must be kept in view—the broad and liberal education of young men and young women and at the same time their scientific and technical training. The land-grant colleges have, in recent years, been in close conference one with another, their presidents and representatives meeting in annual association, each profiting by the experience of the rest in an endeavor to develop courses of study, to establish standards, and to determine the requirements for scientific and technical degrees. It is obvious that there must be a compromise between the old classical ideal of a college course in which "nothing useful is taught" and the equally extreme and inadequate notion that such an institution should be a trades-school. A trades-school does not broadly and liberally educate, neither can it be scientific in its methods. In the nature of the case the framers of the original organic law, of the Morrill Act, and of the state acts, did not, themselves, have a completely elaborated and perfected system of education clearly in mind, but rather a great and fruitful idea which must be left to the college authorities for elaboration and perfection. The development, however, should be in fundamental and sincere harmony with the purposes of the law, and hence the law itself has become the guiding principle and regulating ideal.

While under the law it would be entirely consistent for a land-grant college to offer classical courses leading to the degree of bachelor of arts, and while in some States this is done, in others classical courses, as such, are not offered nor the degree bachelor of arts given. The emphasis is upon science studies and upon the branches of applied science which particularly affect agriculture and mechanic arts. As in all well-established and accredited institutions assuming to give broad and liberal education, certain general studies are considered essential, such as English, including principles of speech and expression, and a sufficient study of English literature to give the student a somewhat adequate standard of individual taste and judgment; brief but comprehensive courses in history that shall familiarize the technical student with the origin and development of the industrial, social, and political institutions, and to fit him for intelligent citizenship in a free country. Some study of modern languages is universally recognized as an important element in all technical institutions of collegiate grade. This is particularly true in those branches or groups of studies in applied science which lead the student to the literature of science in other tongues than our own, and for the technical student to make him familiar with the

language of peoples with whom he is likely to deal in professional and scientific work in after life.

It is obvious that the original act as worded embodies a compromise. The phrase "without excluding other scientific and classical studies" expresses a conservative feeling. It treasures a protest against putting so much emphasis upon "such branches of learning as are related to agriculture and the mechanic arts" as to exclude the humanities and other scientific studies than those immediately related to the industries.

The most characteristic tendency of the land-grant college is not toward greater and greater breadth—an itch to become a university—but toward organic evolution. Its greatest danger is not that of spreading over all creation but rather of becoming too intensely special. Technical studies in the hands of specialists are likely to win in competition with more general subjects for favorable places in the curriculum.

The land-grant college, by its inception and development is essentially an institute of technology. Science is basal in all its work, but its major interest is "science as related to the industries." The two great fields of industry specially mentioned are agriculture and mechanic arts or engineering. Closely and logically affiliated with these two great branches of applied science are domestic technology and veterinary science.

It was evidently the intent that these institutions should be coeducational. We of the Middle West are so thoroughly committed to the coeducational policy that this question seems scarcely debatable. Suffice it to say that there are many young women who desire and who should have the opportunity for technical courses such as the land-grant college is peculiarly fitted to give. The college, moreover, needs the presence and the influence of the women quite as much as the women need the college. Those best acquainted with the wholesome social atmosphere of coeducational institutions, where social life is incidental and rightly regulated, will be least likely to question these statements.

Domestic technology courses should be of collegiate grade and thoroughly scientific in character, and are best developed and given in the atmosphere of a college where the major interest is upon technical phases of scientific study.

Occasionally there are women who desire technical studies or courses in engineering or in agriculture. There will, I believe, be increasing numbers of women taking part or whole courses in agriculture, especially courses in horticulture and in general agronomy subjects.

Where the local state conditions warrant it, a department of veterinary science not only may appropriately but should be established.

Animal husbandry interests are of increasing importance in many States even in some where there has been but limited interest of this sort heretofore. There is a noticeable extension of highly bred and valuable live stock among farmers. The superior value of pure-bred stock for the average farmer has become well-nigh universally accepted. And with this extension of live-stock interests the demand for the scientific veterinarian is increasing. The day of the "horse doctor" is rapidly passing.

Moreover, as we well know, the demands for scientifically educated veterinarians to meet the requirements of government service in the army and in the general administration of the federal laws governing interstate commerce in meats and other animal food products is greater than existing institutions can meet.

Municipalities, too, are rapidly assuming responsible regulation of milk and meat supplies in the retail trade within their jurisdiction, and for proper execution of ordinances covering these matters as well as in the drafting of the proper ordinances, veterinarians who have had advantage of thoroughly up-to-date education in the scientific aspects of veterinary practice are in demand.

The land-grant college is the proper and economical place for the location of departments of veterinary medicine. The necessary science studies will, as a matter of course, be available, chemistry, zoology, bacteriology, and histology being specially important. Certain work in animal husbandry will be there best available. For while the studies of the veterinarian will be largely of pathological and anatomical conditions, he should have considerable instruction in regard to animal nutrition and breeding and the general principles of the care of live stock. A very valuable coordination of courses between departments is, therefore, easily possible between veterinary and animal husbandry and science departments.

ORGANIZATION.

In the organization of departments local conditions as well as logical segregation of courses of instruction must have consideration.

In general, it is my conviction that it is best to hold together under the headship of a single department all the work of an institution that can logically be classed under one scientific subject; for example, there is increasing interest and importance attaching to bacteriology. Scientific students in dairying, in animal husbandry, in agronomy particularly in soil studies, in veterinary science, in domestic technology, and even in civil engineering when studying the strength and character and durability of materials under varying conditions, must give attention to bacteriology. Now, it is of course possible that a special bacteriologist should be added to the dairy department, another to the veterinary department, and so on with no coherence or unity between these various lines of bacteriological work.

Such an organization often appeals to the heads of technical departments. They can thus have the instruction given under their own independent control and can make sure that the special application of the subject which they desire for their own students is made in a satisfactory manner.

This desire for department independence may, however, lead too far, and I believe does when the engineering faculty has its own engineering instructors in modern languages, as at the University of Michigan, and their own instructors in English, etc.

It is not at all unusual that a professor at the head of a technical department is not himself really prepared to direct critically the work of a scientific specialist, as a bacteriologist or chemist, even in the particular field of his own specialty. A professor of soils having charge of experimental work in that field said to me recently, "I am not qualified to do or to direct closely the work of a soils chemist. I want," he added, "a specialist in organic chemistry who is capable of initiative and independent work beyond my ability to direct him."

This general statement and inquiry concerning the proper relation of science and technical instruction leads to a broader question of policy.

On the one hand is the radical scientist who looks with some disdain, not altogether unwarranted, upon the tendency to premature applications of science to some technical subject. Thus to take a class of freshmen who have never studied chemistry and enroll them in classes in "agricultural chemistry" appears to him absurd, and he is fully half right. Chemistry in the elementary phases of the science is elementary chemistry, and can not appropriately have "agricultural" or any other technical adjective attached to it. To undertake to make an agricultural chemist or to introduce to agricultural chemistry a student who has not yet learned the elements of chemistry comes dangerously near to scientific quackery. The best that can be done to give a particular bias or flavor to the subject at first is to select simple problems from the field of special or anticipated interest, just as problems in elementary arithmetic may be taken from the field or from the shop, according to the major interest of teacher or pupil.

The demand which the technical departments make upon the teachers of science is not, however, entirely without justification. The horticulturist very naturally wishes his students of horticulture to be taught botany, with special reference to horticultural interests. He wants his students to be familiar with horticultural nomenclature and feels that the illustrative material for horticultural students while they are studying botany should be taken as far as practicable, from the field of horticulture. He can not see why botany may not and should not be taught in a way to awaken initial interest in horticulture. The departments of science should recognize this practical demand of the technical departments and be sympathetic toward them.

Yet I believe the best interests of the college as a whole, and this means, of course, ultimately the best interests of the students, are conserved by keeping at the head of the science teaching teachers of science. Zoology should be taught by a zoologist, and botany by a botanist, bacteriology by a bacteriologist and chemistry by a chemist. All these should be broad enough to appreciate the element of legitimacy there is in the demands of technical teachers and students, but should command for science itself, irrespective of its particular applications, the respect which is its due. Premature specialization or an abortive attempt at premature specialization is narrowing and puts the student in a wrong attitude—an unscientific attitude toward the very subjects which should

be handled by him in a fearless and thorough loyalty to the method and spirit of science. He should first of all for real scholarship be trained to the scientific method or habit, leaving for the first subordinate the possible or actual applications of the knowledge of principles to any particular field of industry or technology.

An objection which may at times be serious will probably occur to any who have faced these administrative problems under a sense of personal responsibility for policies to be adopted. This arrangement of centralizing under the headship of a science department all the branches of that particular science as it ramifies into the several technical departments will apparently give to the technical instructor of any science subject, as dairy bacteriologist, two directors, the head of the science department and the head of the technical department. It is a proverb well worth heeding in all administrative policies that no man can serve two masters, etc.

It is my opinion, however, that two safeguards well attended to may prevent trouble where those seeking trouble might easily find it. First, men should be selected who are not prone to hunt for trouble, but who possess the happy faculty of adapting themselves to their colleagues and to conditions without friction. This caution should apply to the selection of the head of the science department particularly and to the instructor who is to serve two masters. Second, the respective functions of the head of the science department or scientific critic and supervisor and those of the head of the technical department should, as far as practicable, be defined and understood. The head of the department of soils may, for example, with excellent propriety be quite modest in passing judgment upon the purely scientific aspects of the work of the instructor in soil bacteriology who is instructing soils students in bacteriology, but his opinions should have weight in determining how much time in any group course of study bacteriology should have and in determining what aspects of soil bacteriology should have emphasis. It may be very important that the student should have his attention especially devoted to the influence of bacteria on soil fertility and plant growth, and the soils man is the one to be heard in this matter.

The importance of keeping the college closely correlated in its departments and courses, maintaining organic unity, is so vital as to make it well worth while to guard against the tendency to quasi independence of departments and department provincialism.

Concerning the board of management and control of the state college, there are probably as many opinions as there are methods in vogue.

In Iowa the common board for all state educational institutions has prevailed. Excellent men have been nominated by the governor and confirmed by the senate. Curiously enough, the personal convictions of some, if not the majority, of the men selected for this common educational board were opposed to the policy. But they have entered upon their duties in good faith. It remains to be seen whether the interests of three state institutions are not too varied and important for any one board of trustees, and whether a centralized board, the members of which are to be nominated to the senate by the governor, can so far be kept out of partisan politics as to preserve the state educational institutions from baneful influences.

Suffice it to say that in so far as the president of the college finds his hands tied in selecting and recommending faculty and instruction force, or in so far as academic or administrative freedom is interfered with by political influence, dry rot is certain to result and corresponding inefficiency and demoralization. From all these evils may Heaven fend us!

The standard requirements for college admission are none too high. Four years of accredited high-school work or its equivalent is little enough preliminary training for any student entering upon a scientific or technical course. A low standard means low grade college work. It bids students away from the high schools, where they ought to finish their secondary education. It prevents well-prepared students from entering. They will go where the requirements are higher and there are corresponding dignity and character in the work done. Let there be all the short courses, secondary school technical courses, and extension schools and courses that can consistently be organized and carried forward, but the main business of the state college of agriculture and mechanic arts is scientific direction, leadership, and efficiency. These we must have or the rest will soon run into the shallows. Streams are not in the habit of rising much above their sources, and until the law of physics

and of pedagogy is abrogated we do well to heed its meaning and not allow a base competition for numbers of students or any specious department of the "city high school," or any sympathy for the overgrown boy who, through misfortune, stupidity, or neglect, lost his opportunities for preliminary education to lead us to the vain effort to maintain scientific leadership or to do worthy work with only a short cut from the eighth grade to the freshman class.

The talk, of which we occasionally hear something, that these land-grant colleges of agriculture and mechanic arts ought, perhaps, to be unique and to disregard the standards established by long experience for classical and liberal arts schools, is nine-tenths nonsense and the other tenth moonshine. There is no educational work that requires severer scientific discipline than courses in science as applied to the industries. If the professional schools of law, medicine, and even dentistry find it highly expedient to require one or more years of a college course in addition to high-school courses for admission, the state college can in decent self-respect require no less than four years of secondary education for admission to its freshman classes.

Graduate studies in technical lines can not best be developed and carried forward on the basis of stray undergraduate work in these subjects. There is a good deal of loose current talk about colleges and universities that is wide of the mark in America. The American university, and especially the state university, is *sui generis*. It has grown up out of the democratic conditions of America and is, perhaps, the most typically democratic development of higher education on a large scale to be found anywhere in the world. But the term "university" refers more especially to its variety of departments and lines of work, especially its professional schools, than to its grade of work. Until recently, in the professional schools of our state universities a low standard has been maintained, particularly in entrance requirements. Graduate courses have been added in most state universities, but only so far as a sort of adjunct rather than as a main division of university work. Whether it is the province of the state university, as such, to become primarily a graduate school, I leave to others to consider. It is my conviction that graduate courses should rest upon the strongest undergraduate work. In pure science this might be in the university. Perhaps an organic chemist could best be trained there. But graduate work in technical subjects, particularly in the field of agricultural science, should be developed at the college of agriculture where the undergraduate work is strong. The place for a graduate student in any special line, as in soils or animal husbandry, is where the atmosphere and the soil are ready for this advanced work in the undergraduate studies and in the departments where these subjects are already handled thoroughly in the elementary college courses.

E. A. Bryan, of Washington. I can but commend the general spirit and tone and thought of the entire paper. No problem, perhaps, is of more importance to the land-grant colleges than the determination of the function and scope and organization of those institutions. It was, indeed, a fortunate thing, that in the original Morrill Act so much was in outline and so much of the detail was left to be determined afterwards. An attempt, at that period of educational history, to determine matters of detail would have been misleading, and, perhaps, injurious. It is, perhaps, equally fortunate that in several of the States of the Union, in accepting the provisions of the various national acts, there has been a considerable latitude in the system of organization, and in the definition of the function and scope of agricultural colleges and universities. Though all this was a new thing in the educational history of the world (and had to be wrought out by men in whom educational traditions were fixed, whose philosophy of education was established, whose experience in technical education or lack of experience might have led to diverse results) it is a matter for congratulation that in so many States of the Union and under such diverse conditions, we have such uniformity and almost unanimity of development; so that were we to examine the curricula of those several institutions to-day, or were we to examine the practice of the several institutions, we would find the uniformity very marked.

It was suggested by the speaker that perhaps the separate and distinct college of agriculture and mechanic arts was more typical of the ideal of the

nation and of the legislature in the establishment of these institutions, than are the universities which belong to the system. It does not seem to me a matter of much consequence that this question should be settled or even largely discussed, for, as a matter of fact, we face a condition to-day, and not a theory. As a matter of fact, we have some 18 or 20 States in which the universities are the land-grant colleges of the States, and it is not likely that in any case a change will be made, the institution be divided, and a separate and distinct college of agriculture and mechanic arts established. It is more likely that in some cases there shall be a tendency toward concentration. In the history of the development of the matter for a long time the universities absorbed the funds intended for industrial education, and devoted them to other purposes, usually to the support of the same old system. It was so deeply fixed in the minds of those in charge that real education after all is literary education, that the real means of education is a verbal means—the use of words, of language, of literature—rather than of science and the arts, that the old system prevailed over the new. In so far as science was admitted, it was to be used in a very abstract and not in a concrete way. In many instances the universities diverted these funds, believing that in so doing they were rendering God service. But I am here to say that practically all of them have seen the new light, and I am free to say, so far as my judgment is worth anything, that some of the very best examples which we have to-day of the true spirit and thought of the land-grant colleges we find exhibited in some of our universities. I believe that if I were to pick out to-day the institution which I would regard as the best exponent of the thought of the land-grant colleges, I should pick it not from the class that I represent, the separate institutions, but from the land-grant universities of America. Perhaps this has been due not to the presence in any greater degree of the spirit there, but to the earlier presence of more adequate funds.

When we use this phrase, "land-grant colleges," we are of course aware of the fact that we are using a phrase which is by no means characteristic of the institution; rather a historical phrase, a name which points to the history of the institution in order to get at the unity of these institutions as we see them.

And this calls to mind the fact that we have in this country a group of institutions which are national or seminational in character. This group consists of some 20 or 25 colleges and some 20 state universities, tied together by the national legislation, by the fact that they are to a certain extent under national control, that they are beneficiaries of the national fund, and that they represent a truly national spirit. And I would like to see cultivated to the very greatest possible extent a solidarity of interest among these institutions. There has existed and does exist to-day a solidarity of interest which is going to continue. We have behind us the precedents of forty-seven years since the first Morrill Act was passed. I am sorry to say that this organization is not, in my judgment, to-day quite as representative of this solidarity of interest and this unity of purpose as it was eight or ten years ago. Nevertheless, I believe this solidarity is one of the things which both the universities and the separate colleges of agriculture and mechanic arts should cultivate by all means in their power. I believe this will work to the greatest pedagogical advantage and to the greatest advantage in the development of the great educational idea which they represent, and certainly to the greatest advantage in the matter of organization and in retaining and securing of additional money for this great end. We are bound together not only by the fact that we are national, but also by the fact that we represent what seems to me to be the greatest ideal in education of the last half century

at least; an ideal in which the larger part of the community is served, in which the condition of the larger part of the community is bettered, and in which higher education has, at first slowly and afterwards more rapidly, come to face in a new direction.

I have already said that under the old idea it was believed that the only education was literary education, that the only means of education were the verbal means, the only proper attainments were books, and if science was admitted at all it was admitted purely for the sake of abstract truth. In many cases there seemed to be even an avoidance of the application of science to the practical concerns of life. But there has been a revolution in the last half century in this respect, and the way has been led by the colleges of agriculture and mechanic arts. It is a notable fact, it seems to me, that the influence of this ideal within those universities which are the colleges of agriculture and mechanic arts of the several States has revolutionized in many instances the whole spirit of the institution, so that not one part but the whole institution faces in a new direction. Some of these institutions have developed out of those separate institutions established for the one purpose of agriculture and the mechanic arts. For example, the University of Illinois, formerly the Illinois Industrial University, was, at the outset, an exponent of the new system, only a child of the Morrill Act, and it developed into what is known as the University of Illinois, and particularly in recent years it has had a most marvelous development, as we all know. Maine and Kentucky are similar illustrations. With the establishment of the newer universities, also, even from the very foundation, the new idea was dominating. For example, I think I am not misrepresenting my friend from Nevada here when I say that he is an observer of the fact that the new spirit or idea in education has dominated his institution from the beginning. And in this ideal we have recognized not merely the establishment of schools to train farmers, or to train mechanics; we have recognized the fact that these institutions are after all and primarily educational institutions; that they exist not to make the farmer, not to make the mechanic, but to educate the man; and in the lessons which we learned during our earlier years many of the abortive attempts of our institutions, and particularly of the separate ones, was due to the fact that they had placed before themselves a very narrow function—that of making farmers; that they must make farmers at all hazards, and that it was necessary to keep that function in view as its chief end; that we must not educate him too much or else he will not farm. But we have come to realize that this later development will take care of itself; that our principal function should be to educate the man, and we can do that with no narrow curriculum, but only by laying the basis in a broad and liberal education, one which begins in the earlier years and solidly provides, as suggested, the requirements for admission to the institutions, and this in a curriculum sufficiently broad. We must develop the man and we can well leave the matter of the vocation to take care of itself.

So far as the scope of the colleges of agriculture and mechanic arts is concerned, every one who has given any attention to the science of education at all knows that education, to be education, must cover a sufficiently broad field. I believe that in many instances we have not only confined the curriculum too narrowly to agriculture and the mechanic arts, but that even in the teaching of these subjects we have too narrow a conception. For example, and by way of illustration, I believe to-day that in the matter of agricultural production we are much further ahead than in that very important field of agriculture, the economical disposal of the fruits of agriculture. We know decidedly more to-day about the soil, about tillage, about the production of

crops or live stock, than we do about what to do with these products when we have got them. The proper management, the proper disposal, the whole economic arrangement of society for the care and distribution of the products after we have them, have been very largely neglected. A few years ago, when during a wave of Populism, a western agricultural college appointed three or four professors in political economy or economics, many of us laughed; but, while, perhaps, we might have criticized the detail, the idea underlying was correct. In these economic questions which are so intimately connected with the agricultural development of the country, we are far behindhand. We are not doing enough in the study of the problem of transportation, and we are not doing half enough in the matter of state taxation; we are not doing enough in the study of a whole list of economic problems which are just as closely connected with our work as are questions of production, and I believe that the colleges of agriculture and mechanic arts are in greater danger if they undertake to abridge the scope of study than they are from its enlargement.

It was suggested by the reader of the paper that some history, and particularly that which is connected with the industrial history of the race, should be studied by these several technical departments. I quite agree with him. I would go further than that. I have had in the past some opportunity to study the subject of the history of agriculture, and realize how large a field there is which has to be explored by the original explorer, even before it is taught in the class room. But while I should regard the study of industrial history and the industrial classes as important, nevertheless, I would say also that no college man in any kind of college, technical or otherwise, ought to go forth without a very general knowledge of the history of the world outside of this industrial history. We must make him a broad and liberal-minded man. Held within the narrow lines of a single science or a small group of sciences, he can not have such an education as he should have.

As a question of organization I quite agree with the suggestion of President Storms. A departmental system, it seems to me, is particularly well adapted to institutions of the character which we represent. And as to the details of departmental organization which he has suggested, I would give to them my very hearty indorsement and approval. I believe it has been, and is almost from the nature of the case, the universal experience of the colleges of agriculture and mechanic arts that there should be an opportunity for departmental election. In contrast with the Harvard system of free election, the agricultural colleges have followed in general a system of departmental election. Even within the realm of agriculture itself we are more and more tending toward an election and selection of one or the other subdivisions, as horticulture and agriculture proper, or as agronomy and animal husbandry. And in the engineering courses the same thing is done, narrowing, of course, the limits of the field for free election very greatly. This, we may say, is an almost necessary consequence of the idea lying at the basis of the institutions of this class.

One other point I should like to mention, and that is this: There has been, I think, in the universities which are the land-grant colleges—though perhaps they have not been fully conscious of it—too much of a tendency to regard the one single department of agriculture as being the entire fulfillment of the national and state legislation relating to this subject, and to make this separate department comparable to the separate institutions. If they were to confine for a moment the education of their agricultural students to the curriculum offered by this one department, they would see how erroneous such a view is, and that in no respect whatever is the single department of agriculture com-

parable in its organization or method, or in the details, to the institutions upon which falls the duty of fulfilling entirely within the State the function of the college of agriculture and mechanic arts. A large portion of the work in the university of the college of agriculture or the department of agriculture, as the case may be, may be done and will be done by other departments of the institution. In the department of English, general English will be studied; in the department of chemistry, at least elementary chemistry will be studied, and all of it should be. But, as has well been said, the primary sciences, chemistry, botany, zoology, etc., will touch practically every part and portion of industrial education, and strong, independent departments in these should be maintained. And so within the university, those parts of it which do not regard themselves as part of the college of agriculture and mechanic arts will, nevertheless, contribute to the education of the men in that department, and will discharge a function which in the distinctly agricultural college must be provided for by the establishment of like departments. On the other hand, language and history and economics and other subjects characteristic of the liberal arts courses must also find their place in the college whose chief function is technical and industrial education.

HOWARD EDWARDS. In what I shall have to say, I desire to direct attention to a matter that is coming more and more into the public mind through the attitude of the Carnegie Foundation—the matter, namely, of the scope and work of the land-grant college when separate and distinct from the state university. Were it possible to fix the scope of this work without reference to the law, the problem would be different. As it is, however, due regard must be had to the law, and the public in each State must be informed as to the requirements of that law. Let us for a moment, then, examine the body of laws that originated and shaped these schools.

It is not always recognized, except by students of the matter, that the law of 1862 with regard to the land-grant colleges differs materially from the law of 1890 on the same subject, and that both these laws apply to the separate land-grant college just as rigidly as they do to the land-grant university. Moreover, the State accepting the benefits of these laws can not contravene their provisions by requirements of its own. Between these two laws twenty-eight years intervene, and twenty-eight years do not pass without affecting men's ideas quite materially. The forces and purposes behind the law of 1890, while not antagonistic to those behind that of 1862, are not fully the same and the differences are apparent in the provisions of the laws themselves.

(1) The law of 1862 is quite vague in the expression of purpose. The law of 1890, on the other hand, specifically enumerates the subjects that shall be included under its provisions.

(2) The law of 1862 prescribes as the leading object "to teach such branches of learning as are related to agriculture and the mechanic arts." Now, I submit that to teach subjects related to agriculture and to teach agriculture, as is required in the law of 1890, are two clearly distinct things.

(3) In the law of 1862 is found an additional explanatory phrase—"in such manner as the legislature may prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." After the positive, though general, definition of the leading purpose as given in (2), note how the limitations vanish and the horizon widens with a suddenness and completeness quite bewildering. It is as if the author, after proposing a thoroughly new and untried purpose for a college, grows frightened at his own temerity and takes refuge in stock phrases vague in meaning and familiar of sound. With this most interesting bit of psychology,

almost unique in modern law-making, there is nothing comparable in the 1890 law, which is absolutely certain of its purpose and as inexorable as fate in its expression.

(4) The previous three differences are specific. The fourth, however, is more general and inferential in its nature. The law of 1862 neither lets go of the old formal education nor firmly grasps the new. It does, indeed, recognize the dignity of the active as distinguished from the contemplative professions, and the value of a trained intellect directed upon lines of common activity in life. Senator Morrill was himself not a college-bred man, and it was his private study of traditional subjects done in active connection with mercantile pursuits that gave him in his educational views that curious combination of respect for traditionalism and interest in preparation for active life. Furthermore, he was apparently imbued with the somewhat romantic spirit of "return to the soil," which has its extreme form in the Brook Farm experiment. He was, of course, much more practical than that, but at the same time, he had an idea that the old culture and training should be combined with the practical life of everyday work, and that is the main drift of the 1862 law.

On the other hand, the 1890 law is a blunt repudiation of the education that avows as its object an escape from labor into a world of speculative leisure. It is a flat rejection of all the subjects and methods supposedly essential to an elegant and leisurely culture. It is a clear and definite break with tradition.

As a result of this qualified and hesitant attitude in the 1862 law the modern land-grant college, with its definite and specific purpose and with its enormous influence on all educational thought and progress, had its root, not in the law of 1862 but in the laws of certain States, notably Michigan; while in the case of every university and some colleges founded upon or aided by the land grant of 1862 the funds were diverted to purposes which that law did not expressly contemplate and the "leading purpose" was ignored or inadequately treated.

Such was the situation when in 1890 a new grant was proposed. The 1890 law as originally drafted contained few or none of the differences from the 1862 law that I have pointed out. But representative persons, whose influence could not be ignored, indignant at what they regarded as perversions of the previous law, and in their thought tending strongly toward trade-school ideas, modified it radically, deliberately omitting certain subjects, enumerating those that might be taught under the fund, and placing the word "only" before the enumeration.

It is these differences of underlying animus in the two laws constituting our charter that make a harmonious interpretation of them so difficult. And yet such harmonious interpretation must be made in defining our scope and function, for the second law refers to and incorporates the first as a part of itself. In the end, too, it is fortunate that two forces have been represented in these laws. The vague, halting, and sometimes perverted application of funds on the basis of the 1862 law has been corrected, not alone by the 1890 law and its interpretation, but by the discovery that modern conditions were responding in wonderful fashion to the processes of vocational education as blazed out by the strict-construction agricultural college. On the other hand, the separate agricultural college whose organic state law required that in it the graduate of the common school might commence, pursue, and finish a collegiate course, began to discover under the influence of the university loyal to agricultural education and developing it according to pedagogic laws that both laws, except in the one case of providing for the needs of the colored people in the South, everywhere distinctly postulated colleges, not agricultural high schools or trade schools. So far as concerns the character and scope of the instruction on the land-grant

foundation there is not one law for the separate college and another for the university, but there is the same law for both. Whatever is required of the latter is also demanded of the former; whatever is prohibited to the former is also forbidden to the latter.

It is in attempting to define the term "mechanic arts," a term now practically as obsolete as its counterpart, "liberal arts," that we find especial help in a comparison of the two laws. The term is evidently, in the 1890 law, simply taken over from the 1862 law, without any attempt to fix the meaning of a practically obsolete term; and at a time, too, when nearly, or perhaps, quite all the colleges were giving instruction, not in trade work, but avowedly in engineering. In the 1862 law, the term is clearly not subordinate to the term "agriculture" but coordinate with it, and the two are used together to include the whole realm of action of the "industrial class." In this law, agriculture is that part of all industry that produces from the soil, while "the mechanic arts" serves as a designation for the great transforming and transporting industries. No one who reads the law seriously can for a moment think that the term is subsidiary to that of agriculture, and is satisfied by the teaching of farm mechanics. It includes with agriculture the whole realm of industry treated from a college standpoint, and only this interpretation will harmonize the requirements of the two laws.

While then the practice of the two classes of schools in the past has diverged somewhat in response to the two divergent forces operative in creating the two laws, it is now recognized that a single direction was given as a resultant, and in this direction all land-grant foundations must move.

In a conversation with the president of the Carnegie Foundation, I was asked this specific question: "Why do you not, you men of the separate agricultural colleges—why do you not formulate and state definitely what your function is?" And so I have undertaken, in response, to formulate in accordance with this harmonious single interpretation of the two laws, a statement, as follows:

"First. That the series of United States laws creating so-called land-grant colleges and formally accepted with the accompanying funds by the several States, constitutes a binding contract and charter which neither the State itself nor we as administrators for the State, have any power to evade or disregard.

"Second. That the State laws may direct the disposal of state funds to provide whatever instruction local conditions may demand, yet they can not so modify the nature and character of the land-grant institutions as to vitiate the requirements of the contract entered into by the States with the nation.

"Third. That the United States laws, in defining the character of the land-grant institutions, specifically stipulate that, except in expressly stated cases in the South, these institutions, founded and maintained under United States laws, shall be colleges; that is, institutions doing work above the high school and bestowing degrees for such work.

"Fourth. That these laws prescribe the scope of such collegiate instruction on the land-grant foundation and affirm one leading object, namely, education for industrial life and citizenship, all other education under the land-grant endowment being by inevitable implication subsidiary and tributary.

"Fifth. That these laws further define the nature of this collegiate instruction, not optionally but affirmatively and imperatively, requiring that instruction to be not merely in the great productive industries, agriculture, horticulture, forestry, etc., but also and on an equal footing in the great industries that transform and transport things and produce food, clothing, and the like from the raw material which the farmer has produced.

"Sixth. That this industrial education in the mechanic arts, so required by the law of all institutions that in their maintenance exist wholly on the land-grant fund, though being collegiate in grade, is and can be only what is in modern terminology known as engineering in its various forms of application.

"Seventh. That, considering the foregoing interpretation of the law, and considering further the present and future service of the people, we regard the function of the institutions on the land-grant foundations, so far as provided by national endowment, as one and the same, whether embodied in a university or separate in location and organization.

"And finally, that this function, affirmatively defined, whether to be carried on by a university or by a college, is to give such collegiate instruction as will fit for leadership in industrial life, whether on the farm, in the factory, on the railway or highway."

In a discussion of the function and scope of the land-grant college it has seemed to me that a statement of that kind would be proper. I also desire to put it forth here that it might have such consideration as can be given it before presenting it in the general meeting of the association.

A. B. Storms. It seems to me these resolutions are very pertinent and extremely important in view of the request from the chairman of the Carnegie Foundation for such an expression by us. If it would be in order or desirable that we take some formal action here recommending some such statement by the general association, I would be glad to make such a motion.

D. W. Working, of West Virginia. I would suggest that we make a motion that the chair appoint a committee of three to go over that statement with its author for the purpose of studying its phraseology rather critically and being able after that critical study to state it more positively and amend it in some slight particulars.

Howard Edwards. I think that is a very valuable suggestion and I should like to see it carried out. I have no desire to project before the convention an ill-advised or ill-worded set of resolutions which we will not have time to consider.

The motion was made and carried.

The chairman appointed on the committee Howard Edwards, D. W. Working, E. A. Bryan, of Washington, and W. E. Stone, of Indiana.

K. L. Butterfield. President Storms spoke of organizing departments along the lines of subjects. Now, we have, of course, the research and experimental work that is to be carried on through the experiment stations, the regular college teaching, and the rapidly growing type of work which we call extension work. Thus we have there three rather distinct types of work to be cared for by the institution. The question of effective organization for the whole institution, it seems to me, involves not only the question of organizing departments by subjects of study, but also some cross organization. I would like to ask President Storms how, in his opinion, these different types of work may be correlated so that there is administrative unity and yet a fairly clear division of labor?

A. B. Storms. It seems to me the gentleman has practically answered his own question in the way he has put it. I am no oracle, and we are in the experimental stage ourselves and are watching with a good deal of interest other institutions and their method of organization. One or two things, however, seem to be fairly clear, and one of them is that it is unwise as a matter of policy to have work in animal husbandry, for example, carried on under independent heads not closely correlated in the different lines mentioned. For example, for the extension work in animal husbandry, it seems to me very desirable, as in other lines of extension, that it should be really an extension of

college ideas and college teaching; of course, made simple and practicable, but it should be a real digest of the college work, and therefore we try to keep a vital relationship between extension work in the field and in the department at the college. It is a relationship that is mutually helpful. A college department totally isolated from the field and from the people will become academic and abstract. But especially the extension worker should be in such relationship to the college department that he will be constantly under its inspiration and its instruction, so that the subject-matter which the extension worker is covering will be critically examined and approved by the head of the college department. Beyond that, in the field, he, of course, has to be under the extension head. The extension head is the administrator. Of course, there is abundance of opportunity for slight difficulties to arise. Whether they do or do not depends upon the personality of the men concerned. The question of unity under the head of the college department in subject-matter and methods approved, and all that, is important. Otherwise there may be conflicting teachings and the extension work may become superficial. And the same thing will be true if the station is undertaking to carry into the extension work any scientific subject. It ought to be approved and critically examined by the head of the corresponding science department in the college.

So far as station work is concerned, I believe Chairman Jordan's position, or that of the committee which he represented a year ago, is the sane policy; that experiment-station workers should give their entire time to the experiment station, but the head of the department in the college may very well, and perhaps best of all, supervise the experimental work to be carried on in his subject. Below him it seems to me as though the time of the assistants should be given to one field or the other and that they will become more and more efficient, according to their capacity, if they be single-minded than if they be double-minded.

ENTRANCE REQUIREMENTS FOR LAND-GRANT COLLEGES.

J. L. Snyder, of Michigan, read the following paper:

The rapid development of the land-grant colleges was due to the fact that they appealed to the good sense of many educated people, as well as to the needs of the industrial classes. They started at the bottom and were suited to the educational conditions of the common people.

Country boys 40 miles from a high school were not told to go home and get two years of a modern language, mathematics up to trigonometry, a year of physics with a full note-book, showing laboratory experiments, etc. If such requirements had been a condition for college entrance, not many men present of technical training would have gone to college.

The land-grant colleges exist for the people, not for the faculty; not for the few who can meet high entrance requirements; not for the industrial classes alone, but for all, rich and poor, learned and unlearned—for anyone and everyone who has capacity to learn, and moral character of such standard as to permit him to safely mingle with pure-minded, labor-loving people. These colleges were established because the higher education at that time had nothing for the masses—for the people who worked with their hands for a living.

Of course, no substantial progress can be made without organization. This means standards for entrance; standards for promotion to the various courses; standards for graduation. These standards should not be arbitrarily fixed by a faculty, or board. There is another party to be considered. The people who support these colleges and for whom they exist must not be ignored in fixing these standards. I am not speaking now of the standards for the various academic degrees conferred by colleges upon their graduates. The land-grant colleges having assumed or presumed to grant the same degrees as granted by the traditional long-established institutions should not lower the standard, and thus bring into disrepute the academic degrees of long and honorable standing. These degrees when granted by the newest type of schools should represent

practically the same amount of work as the same degrees conferred by the literary and classical colleges. But in the fixing of requirements for entrance, in deciding beforehand who shall and who shall not have the advantages of these schools, it is obvious that the people who support the school must receive the first consideration. The democratic principle of the "greatest good to the greatest number" should not be ignored when standards for entrance are decided upon. The application of this principle does not necessarily mean that the colleges should try to reach all directly, but it may mean that all can be reached more effectually by the college giving its efforts to the training of a comparatively few, who shall instruct the many by means of books, lectures, and by providing an effective and wholesome leadership.

The greatest work done so far by the land-grant college has been the training of leaders. One school in each State can necessarily do but little in educating all the people. It should prepare the teachers, the writers, lecturers. This part of its work is imperative. It may also, and should give practical training in short winter courses, institutes, corn and fruit trains, and in various other ways to as large a number as possible. But the young men of exceptional energy and ability should be given an opportunity to come to the front. If they have access to high schools, they should be expected to take advantage of these schools before applying to the colleges for entrance. Many States, however, have been able to furnish high-school opportunities to only a small percentage of their youth. If the agricultural and mechanical colleges in these States were to admit only such applicants as had full preparation to enter the freshman class, they would have very few students—not enough to command the attention and support of the people of the State. The land-grant colleges must have students—they must reach the people, and if the young men and women do not have opportunities at home to prepare for entrance to the freshman class the college must take them as they are, and give them this preparation. Just as rapidly as possible the responsibility for this preparation should be thrown on the local communities. The public schools should give this preparation, and the colleges should encourage them to do so and at the earliest possible date transfer the entire burden of such work to their shoulders. In the meantime, however, the college should stand to and render assistance and save as large a number as possible.

The land-grant colleges are local institutions. With few exceptions, they draw very few students from outside their respective States. They strive to minister to the actual needs of their own people. This being true, it seems obvious that the standards for entrance to these colleges should be governed largely by the educational conditions existing in each State. For instance, Michigan has more than 500 high schools. School districts are compelled to furnish high-school privileges, or pay the tuition of students if required to go to other districts or cities for such instruction. This brings high-school privileges very near to practically all the people. It has taken three-quarters of a century under exceptionally favorable conditions to develop such an educational system. Many other States have done equally as well if not better, while a large number, some young in years, others compelled by the presence of two races to maintain a dual system, can not for many years to come maintain anything like a complete system of secondary education. In such States and in all States, our colleges should meet the educational needs of their constituencies. They should do this in their own way. They should fix their own standards. This problem is distinctly local, and should be settled by people on the field, and not by national conventions.

The product of these institutions, however, is not local. It passes from State to State bearing a certain label and claiming recognition on the strength of this trade-mark. The public is interested in this product. It has a right to expect and to insist that it be properly labeled. The value of the label is not fixed by the college which places it on its product. The B. S. label and the A. B label have a certain traditional value the world over. No institution has the right to place this label on an inferior product. If local conditions compel a college to admit students with little preparation, it does not justify the institution in maintaining a correspondingly low standard for graduation. If those who enter college with little preparation aspire to graduation, it is only fair to them and to the educational world that they be compelled to spend the same time and effort to secure a degree as that required by the older and larger schools. Hence, let local conditions govern the entrance requirements, but in the conferring of degrees let every college adhere to the standard as to the

time and amount of work established and maintained by the institutions of recognized merit throughout the country. The prevailing standard for entrance to the freshman class in colleges and universities of good standing is usually fifteen units, a unit standing for one subject pursued throughout the school year, with five and not less than four recitation periods per week. These fifteen units must consist of a certain amount of work in English, Latin, modern language, mathematics, history, science, etc. These requirements have been fixed arbitrarily by the colleges and universities. The effect has been both good and bad—good in stimulating schools to greater efficiency, and bad in laying too much emphasis on those studies which serve as a foundation for courses in the institutions of higher learning and not enough on those subjects which prepare students to earn a living after their school days are over.

However, without any encouragement or assistance from those who fix the entrance requirements and thus dictate in a large measure high-school courses, certain practical subjects, such as manual training, agriculture, domestic science, and domestic art, are fast pushing their way into our high-school courses. Nearly every good high school in the country is now teaching one or all of these subjects. The instruction in these technical branches is given by experts—by teachers who have had thorough preparation and who appreciate the disciplinary as well as the practical value of this work. In the near future these industrial studies will occupy not a secondary place, as now, but a first place in all our high-school curricula.

Is not the time at hand when our higher institutions can afford to recognize this work and allow it to count under certain conditions as a part of the fixed number of units required for entrance? It seems to be a peculiar and strange condition which insists that large quantities of shopwork shall be taken in order to graduate from certain degree courses and at the same time refuse to accept shopwork of much the same character as any part of entrance requirements to such course. The same condition is equally true with such subjects as agriculture, domestic science, etc. The objection to the acceptance of such work, when properly done, as a part of entrance requirements is simply the last remnant of the old idea that such work had no educational value and should not be classified under the head of education. The land-grant colleges years ago exploded that idea, and now should be the first to recognize this work in secondary schools and to give it proper credit in the scale of units for entrance.

The question of entrance requirements has been under discussion frequently of late, because of certain standards insisted upon by the secretary of the Carnegie Foundation. He is charged with a great trust, and it seems to me that he is handling an exceedingly delicate and complex problem with rare skill and discretion. His field of operation is a new one, and he should be given every assistance possible by educational leaders. Even low requirements for admission to a freshman class brings sadness and disappointment to many aspirants, so disappointment to many institutions will be the result whatever may be the requirements fixed by the Carnegie Foundation. The worthy student is often the one who fails to meet the requirements for entrance, and likewise the worthy institution will be very often the one turned down by the office on Fifth avenue. This is no reflection on anyone, but merely the natural result of an administration where standards are and must be fixed and adhered to. While it is no doubt very desirable to the officers of a college that it be admitted to the benefit of the Carnegie pension fund, yet there are other things much more desirable. Of the two, it is much better for a college supported by taxation to retain the confidence and loyal support of its constituency than to have the benefits of the Carnegie Foundation. Is there not grave danger that our colleges of agriculture and mechanic arts, in their strenuous endeavor to secure the benefits of this fund, may lose that public confidence and support which is so essential to their progress? They have been eminently successful because they have kept close to the people. They have anticipated their needs and tried to render helpful assistance. Their success in the future will be in direct proportion to their ability to retain this helpful spirit and in return retain the confidence of their patrons. Their hope is in the people. Their success is not dependent upon the endowments of wealth or the privileges of pension funds. If our colleges are true to the people, the people will be true to them. If they are not able to qualify for acceptance as beneficiaries of the Carnegie pension fund, the States to which they belong will, no doubt, ere long

establish pension funds for their benefit. Our colleges should stand true to their constituencies, let come what may. If they can receive the benefits of this magnanimous and magnificent fund without sacrifice, well and good; but if standards are to be unduly raised and other changes made which will lessen their efficiency, they should freely and willingly decline to make the sacrifice.

Church schools may deny their parentage and may shatter their traditions of sacred and hallowed memory in order to become beneficiaries of this fund, but our colleges are of royal lineage; they belong to the sovereignty—the people—and can not afford to either lower or raise their standards beyond that which is for their best interest to gain the favor of any endowment or beneficence, however great.

As the public educational system develops in each State standards for college entrance will advance. They should be sufficiently high to serve as a stimulus to secondary schools, but not so far advanced as to create a gap between the public-school system and institutions of higher learning.

W. E. Stone. I agree so well with what has been said by President Snyder that I do not care to controvert any of his statements. I prefer rather to emphasize some of the points in his paper. The land-grant colleges are, to my mind, more nearly the ideal of democratic educational institutions than anything we have in this country or are likely to have, and educational democracy is a thing we should cherish. We may do it by studying the educational needs of the community which we serve, but I do not mean to say that we should cater to whims or superficial demands or waste our means in doing things of little or no educational value. The colleges must be leaders educationally, and in so acting they must strive to establish high educational standards. While none of our colleges should attempt to set up a standard for entrance which is beyond the capacity of the better schools of the State, or which will operate to exclude any large proportion of public-school graduates, I deem it to be their duty, particularly in States where the public-school system is not well developed, to seek to constantly stimulate and uplift the standards of those schools and to recognize the best schools, so that the influence of the college should be felt all through the community as standing for scholarship and thoroughness and the best possible advancement in its educational requirements. Our colleges should, moreover, very carefully protect their degrees. If we are critical in this respect the degrees will come to stand for a definite attainment. The degree is essentially evidence of an educational standard, and ought not to be debased. Consistent action in this particular may mean that many of the colleges must have a large percentage of students who are not candidates for a degree. That is well, if necessary. Those who are candidates for a given degree ought to meet practically the same requirements, no matter where they may be or in what State their college may be located.

On the other hand, after establishing high standards of admission and attainment for candidates for degrees, the colleges should make provision, in my judgment, for giving entrance to students of all classes and all preparation, who come to college wanting something which they can not get anywhere else. Now, that is a very large undertaking; it is beyond the means of many of our institutions to do, perhaps, but that is what they should try to do. This is essentially the democratic spirit of education which should exist in all of our institutions. If we can supply the young men and women of our State with useful education or training which is going to react to the benefit of the State in citizenship and in industrial efficiency, and which is not available elsewhere in the State, then we ought to do it, taking care first that those who come have the best preparation which they can get, and then, so far as our rules will permit, extending the hand of welcome to all who find in the institution something of use.

I do not think the true educational policies of the land-grant colleges are going to be stampeded or dominated by the attitude of the Carnegie Foundation. I like something of the spirit of President Snyder's paper, and feel that we are not to look to that source for protection, but that we are to look first to our home people, our home interests, and our home needs, and strive to do that which is best for them. In due time the Carnegie Foundation will recognize that the work of our colleges is thoroughly educational, in the true sense, and that it will become, in the process of evolution, of sufficiently high standard to merit even their approval.

We hear a good deal these days in protest about the influence of the colleges upon the high schools in shaping the curriculum and functions so that they shall lead up to college entrance. This criticism can be met by broadening the entrance requirements of our colleges. If there is anything in the high-school curriculum which gives skill, training, and intellectual power, then that ought to be recognized, in a degree at least, for entrance to college. The high schools are not supplemental and subordinate to the colleges; they are public institutions themselves, established for public use and training of youth without regard to colleges. As you well know, a large proportion of high-school pupils do not go to colleges, and their training should have reference to this fact. High schools should be kept as public training places for the public, in my judgment, without particular reference to the demands of the colleges; and the colleges should adjust their needs and their requirements to the curriculum which is best suited to the functions of the school. The colleges should accept for entrance, in part at least, any systematic training which has given to the student intellectual power and the ability to do things.

It sometimes happens that there comes to Purdue a man of mature age, who has been out of school a number of years, who has been earning his living, who can do a man's work at anything. He may not have graduated from a high school, but I regard such a man as quite as well qualified to do college work, assuming that he has knowledge of certain antecedent branches, as the raw high-school boy who has never had any experience in dealing with men or the problems of life.

Admission to college should be on a broader basis than the present conventional requirements, recognizing a high-school curriculum of greater use to the average pupil, and the equivalent value of personal experience in practical affairs.

The whole problem of college entrance requirements is, after all, something which can not be standardized for the whole country, and I do not approve this idea of attempting to standardize everything in education. There are state problems, local problems, and they should be studied with two things in view: First, always, the educational idea, the uplift, the striving toward the highest and the best thing that each locality can produce; and, second, the coordination of the college work with actual conditions in that particular locality. If we keep these two things in mind and strive for them earnestly, we need not be very much concerned, generally speaking, about standards, or the requirements of the Carnegie Foundation, or anything of that sort; because we shall be doing true, honest, conscientious work, and the best work which can be done for our respective communities.

D. W. WORKING. I have recently been making a little computation having reference to this Carnegie Foundation. I found that the appropriation made by the legislature of Kansas for the support of the agricultural college is more than 4 per cent on the entire fund at the disposal of the Carnegie Foundation.

Now, if that could be computed for the country over, and the resources of these land-grant colleges be capitalized, how big that capitalization would be compared with the pitiful $15,000,000 of the Carnegie Foundation. I think President Snyder has made a good point in insisting upon fundamental loyalty to the people as the primary subject in the conduct of these institutions.

HOWARD EDWARDS. I would like to say a word in regard to entrance requirements, differentiating them into two classes. There are certain things which all college work rests upon and which are integral parts of a college course. We have, for instance, English and mathematics. You can not do college mathematical work without having some mathematical work preceding it. Now, in considering what shall be the entrance requirements, I think that the classification between those things which are essential for further work and the general requirements should be made very distinct. In fixing our entrance requirements we have tried to reduce the first class to just as low a number as possible. In the institution I represent we have placed in the first class 3 units in English, 2½ units in mathematics, 1 unit in history, 1 unit in modern language work, and 1 unit in physics. That is the classification on the one side, the individual things that must be known, the body of knowledge with which a man must come to the college in order to take up the college work, because those things are continuous. Now, we have made up the remainder of our entrance requirements by doing just exactly what has been suggested: namely, by valuing a large range of knowledge—science, history, economics, civics, language, and the practical work—practical agriculture and shopwork. To the man who comes from the farm, no matter whether he has had farm training in the high school or not, if he has the requisite knowledge of practical agriculture we will give a certain amount, I think it is a unit, just for that practical knowledge on the farm. In the same way, we give a man who comes from the shops one unit for his practical knowledge in that direction.

I doubt whether it is to the advantage of many of the state institutions to go upon the Carnegie Foundation. At the same time, that is incidental. What I want to insist upon is that there is a clear distinction which meets the practical needs of the land-grant institutions, and is in harmony with the democratic tendency that President Stone suggested.

E. A. BRYAN. I think we have reached the point where academic freedom has extended itself as to the requirements for admission. Stanford University undoubtedly led the way, but Harvard and some of the older institutions have followed, and there are very few institutions now which do not recognize a wide range of possible subjects of the secondary grade which may be presented by candidates for admission to the colleges or universities. The main thing is, I think, that we have a sufficient quantity and quality within the range generally recognized by the most advanced institutions. I think we should require the same quantity of studies in the schools that would be required of any of the better high schools in the land. In other words, 30 semesters' credit or 15 units is by no means too high a requirement for admission to our land-grant colleges of any kind. If we have sufficient freedom within these limits, then that quantity is about right. And these subjects, I think, should be studied in some secondary school, in the agricultural high schools, or other high schools. I do not think that we need to feel that there is any danger with the Carnegie Foundation if that is done. I think the foundation undoubtedly has a liberal attitude so far as the number and variety of subjects required for admission is concerned. It is allowed in the case of such great universities as Harvard and Stanford. It certainly would be allowed in the land-grant colleges as well, provided there is a sufficient quantity of work done and very well done.

I think a mistake was made in the early period of the agricultural colleges in having too low requirements for admission. I think the interests of the people as well as the interests of the institutions require that high standards for admission should be maintained.

A. B. Storms, of Iowa. I do not think we ought to encourage the idea here or let it get out from here that we are taking a sort of critical and uppish attitude toward the Carnegie Foundation. That Foundation is undertaking a great public service in trying to standardize educational institutions, and it is the only agency that is aiming to do so. They have set before themselves a voluntary task to do so, but it was one that needed to be done and needs to be done, and they are pursuing their work with great courage and, I think, with great discretion, and are likely to arrive at results that will be very valuable. In my institution we do maintain and for the present shall maintain a fourth year of advanced preparatory work, so to speak, for the graduates of three years' high schools and carry them over the freshman's year. I believe we ought not to yield too easily to the complacent notion that we can not and ought not to establish a regular standard for admission. This talk about getting nearer to the people is most of it bosh. There is no greater service that we can do the people of our constituencies than to establish correct educational standards, and perhaps no institutions are nearer to the people or better able to do that than we, I mean the land-grant colleges. We can do no nobler service to the public-school system of the State than to establish those standards and maintain them. We have no moral right, when the public schools are in any adequate degree able to do this work, to invite their students to leave their own high schools and come to us. Missouri is an illustration of the beneficial stimulative effects of institutions like its university fixing the standards, and the high schools responding to them, as they have done in that State. That is a splendid service to the cause of education, and we can render no better service to the young men and women who wish education in a vague and hungry way than to make definite requirements of them. I entered a high school in my eighteenth year; I got through in a little less than three years, being a little more mature than the average, and I am profoundly grateful that no misconceived educational philanthropy opened a side door into a college for me. I think every young man will be better in the end if he is held to right and rigid requirements. We may make provisions for the young man of 25 who wants some special work, but let us do it for him, of course, as a short-course student and not as a candidate for a degree, and protect the degree by protecting the entrance requirements. In the end we will have to come to that. The logic of the situation leads us that way, and we are fighting against our best interests in taking an unfriendly attitude toward the value of the standards which the Carnegie Foundation is standing for; we are simply fighting against logic and against truth, and in the end truth and logic will prevail and we ought to welcome that conclusion.

The section adjourned until Thursday, August 19, at 2 p. m.

Afternoon Session, Thursday, August 19, 1909.

The section was called to order at 2 o'clock by J. C. Hardy, chairman pro tempore.

Officers of the Section.

The chairman named the following committee on nominations: E. A. Bryan, of Washington; K. L. Butterfield, of Massachusetts; and R. W. Silvester, of Maryland (see p. 99).

Medium of Publication of Scientific Work of the Stations.

E. Davenport, of Illinois, then brought up the subject of a medium or journal for the publication in a scientific way of the results of experiment station work, which subject he said had been under consideration by the committee on station organization and policy of the section on experiment station work of the association (see p. 48).

On motion the matter was referred to the general session of the association with the approval of this section.

Recommendations Regarding Extension Work.

K. L. Butterfield. The committee on extension work in presenting its report to the association instructed the chairman to move the adoption of the report. There are three distinct recommendations in the report that would seem to require the action of the association. All these, I may say, were recommended last year. The first refers to an amendment to the constitution providing for adding to our association a section on extension work. The other recommendations are, first, that Congress be requested to grant the franking privilege for bona fide extension publications; and second, that the association indorse the idea of asking Congress, as soon as it may seem wise, for a federal appropriation for extension work.

The committee asks to have the report adopted with the understanding that such action need not commit the association to an indorsement of every word or item of the report. The committee has outlined in its report a plan for a proposed bill in Congress to cover this matter of the appropriation. Undoubtedly different individuals in the association will differ widely as to the details of this bill. But this outline was presented as embodying, in the judgment of the committee, the principles which ought to underlie such a bill. It was the hope of the committee that the association might feel like adopting the report because of the very definite recommendations which it makes and because of the main idea with regard to the scope and character of a federal appropriation.

The first recommendation of the committee to be considered is that there shall be organized in this association a section on extension work. We went over this matter carefully a year ago and since then have had it under advisement as a committee. We have consulted with a large number of men who are interested and especially the men who are now undertaking the extension work. We come to this association at this time with a renewed and unanimous recommendation for the new section.

G. E. Fellows, of Maine. I do not like to appear as standing in the way of progress; decidedly I should prefer to be on the other side. I see some objections, however, to forming a new section in this association. I think the formation of a new section might tend to prevent the progress which we all desire. In the first place, it has been arranged now on our program that we may have two sections meeting at the same time, as we do now in the afternoon. If we had a third section we should be under the necessity of having a longer session or at least a session lasting over more days, or of having three delegates from each institution instead of two; and another difficulty would arise which I think could not be obviated by having three delegates or having longer sessions, and that is, that this question of extension work is one in which the presidents of the association are vitally interested. They must be vitally interested or it can not succeed. I myself would like to be present at all discussions on the question of extension work. I could not do that if there were a third section. My duty is here in the administrative section. We do not have

any more profitable topic for discussion than extension work in this administrative section. To be sure, we should have a director of extension work, and he might come here if he wished to, or if we could send him; but to take extension work entirely away from the administrative side of the colleges and have a new section meeting at another place and at another time, it seems to me would be unfortunate. I do not think it will prevent the growth of the extension work to retain that feature in this section; it does not belong to the stations; it belongs to the administrative officers of the institution, to the college section. It is primarily a college topic.

L. H. Bailey. There are two questions involved in this report of the committee on extension work. One is the general argument, on which they found their proposition, and the other comprises three recommendations growing out of it. I do not see how we can discuss any one of the three recommendations without discussing the argument and the fundamental proposition on which it rests. If we accept the proposition of the committee as to the fundamental importance of extension work, then it becomes only a question of ways and means and the proper opportunity or time in which to adopt the other part of the report. If I understand the report of the committee aright, it considers that the land-grant colleges have a tripartite function, these functions being coordinate one with the other: The college work or nucleus, the extension work, and the experiment station work. If I gather correctly the attitude of the committee, it does not consider extension work to be "college" work any more than research work is "college" work. In cases in which the experiment station is connected with the college or with the university, the president of the college or university is naturally the administrative officer to a greater or less degree of the experiment station at that institution. For myself, I should not accept the premise that the extension work is college work in the sense in which we have defined college work in this organization. I take it that this association represents the essential work of the land-grant colleges, and I think it is indisputable that the essential work of the land-grant colleges is of the three kinds, representing three types of mind and three lines of public usefulness. I recognize, as President Fellows says, that there is a difficulty in having a three-ring circus. I do not know that there is more difficulty with three rings than with two. I should like to attend every one of the section meetings, whether experiment station or college. I should have the same feeling if there were three rather than two; the delegates are compelled as a matter of fact to take their choice. The questions of larger policy which concern all three sections would naturally come up in the general sessions of the association.

I am convinced that the time has come for us to add the third section, in order that the association may exactly and adequately represent what is coming to be the proper and necessary work of the land-grant colleges; and if we do not adopt this course now we certainly shall be forced to adopt it within a very few years. I should like to see the association accept the report of the committee as its general line of policy, leaving the question as to when it shall adopt the three special recommendations for further discussion. I am not at all sure that the time has now come when we should adopt all three of these recommendations for immediate action. Perhaps if we work out one in each year it would be quite sufficient. I am ready now to adopt the first one, which is the adding of a new section. I think this would tend to clarify our ideas by defining the purposes of the colleges of agriculture. I can not conceive how a land-grant college can function properly unless it develops in these three lines. And, on the other hand, I can not conceive of any kind of work coming up in the future that would not fall into one or the other of these three divisions.

G. I. Christie, of Indiana. Last fall, at the time of the association meeting in Washington, a large number of extension workers gathered and formed a temporary organization. It was the feeling at that time that there was a great need for these men to come together and discuss problems of extension work. We have in extension work a field that is new and altogether unorganized. We have at the present time no two States following exactly the same line of work; perhaps we never will. Different States are attacking similar problems in entirely different ways, while I feel, from my knowledge of the extension work, that they might be dealt with in the same way. If we could bring our extension workers together, and if we could have an opportunity to thrash out the problems that confront the several workers, great good would result.

The time is now ripe for an extension section to be formed in connection with this association. Extension work is so intimately and directly connected with college and station work—and it affects the policies of these institutions in every way—that we can not afford to have extension workers come together at any other time than at the time of the meeting of the Association of Colleges and Experiment Stations. For this reason, as secretary of the Extension Worker's Association, I am here to ask that you give your consideration to this matter of allowing us some opportunity to come together and thrash out these problems of extension which should be thrashed out at the earliest possible moment in order that the work may be better organized and promoted.

H. L. Russell, of Wisconsin. I feel that this appeal to us is one that should not go unheeded. It seems to me this child is already born, and it is a question whether or not we are going to adopt this new addition to our agricultural family. The work of extension is, to my mind, one of the most important lines in which colleges can engage. It is one to which the people will respond, and success will as certainly follow in the extension work in the experiment stations as in the academic work which is carried on within the walls of the institution. I believe, with Dean Bailey, that we should have this tripartite arrangement of agricultural college work. It seems to me if we accede to this request and recognize that in allowing this extension line of work to be introduced into the work of the agricultural colleges and experiment stations we will be doing ourselves a service, as well as them. These people will sooner or later get together in some organization or other; and so far as I am concerned, I would rather see the extension workers affiliate themselves with this association than to go into the Association of Farmers' Institute Workers. It is true that the farmers' institute worker is engaged in extension work. Still, in some States that work will not be closely affiliated with the extension work that is carried on under the college, and I believe the time is already ripe for the organization of another section of this sort. I appreciate the point which has been raised by President Fellows as to the difficulty of administrative officers keeping in touch with all of these lines of work, but the program committee can arrange the papers so that matters of common interest are presented at a time when there will not be a conflict, and there will be a sufficient amount of sectional material that is of more detailed character, in which the administrative officer may not be interested. I feel certain that it would be an advance move for us to organize a section of this sort.

D. W. Working. In my own State of West Virginia, shortly after we established the extension department in the college of agriculture, our board of agriculture, which supports the farmers' institute, appointed a man to undertake essentially the same sort of work. Subsequently they saw their error and abandoned the work, leaving the field to us. There is a demand for this sort

of work; it comes up from all parts of the State, I think, and the extension workers who are in the field feel the need of all the legitimate encouragement they can get. Now, if this association, which stands as nothing else stands for the work of the agricultural colleges and experiment stations, will recognize the dignity and the importance of this work by providing a section for it, I believe that it will in some places, like my State, double our power to serve the public, and in serving the public we are serving the institution. This association will have put strength in my hands and given me greater power by dignifying the work that I am undertaking to do through this creation of a section. As an extension man I have now no right here; I must come here as a representative of the college, not as an extension worker. There happen to be three extension men at this association, and we think that there might well be 30 or 40 of us here next year if there is a section which will give us a chance to present our own work in our own way, because we learn some things about the extension work now that our presidents do nót learn, because they are away from the center and we are right close up to it. The problem is with us personally, and we are the men who can work it out and discuss it in detail.

C. F. Curtiss. There is another principle involved in this question to which I would like to call attention and which I consider exceedingly important at this time. That is that as the extension work develops in the various institutions I believe one of the most important problems that will arise will be the proper coordination of that work with the college and station work. I think it highly important that the organization of station workers be properly coordinated with this association. Their work is a part of the work of the land-grant colleges, an essential part; it is conceded by all. And their organization ought likewise to be a part of this association. Without that coordination the extension workers are naturally going to affiliate themselves with the farmers' institute work, and in doing so they will not be recognized and, in fact, will not be a part of this association. That will tend to draw away their work and interest from the college and station organization. That, to my mind, would be a serious mistake. I recognize, as many of you do, the difficulties we have had in properly adjusting our present plan of organization, and I recognize the satisfaction that has grown out of this plan. But we formulated this plan of organization at a time when we did not have the problems before us that we have to-day. Since then a new line of work has developed. There are these three important lines that are permánent and fundamental, and there appears to be a very good reason why we should recognize this third additional line now and give it a place in this organization.

I realize the force of what has been said concerning the vital interests of the college presidents in extension work. That is true, but the deans are also vitally interested, and many of the deans are directors, and there is some conflict now between two sections meeting at the same time. There is scarcely any argument that can be raised against the creation of another section of extension work that does not equally apply to the existing sections. I think we will have to adjust that in the arrangement of the program. There must be, I think, a recognition of this extension work. If we recognize it now we will be in a position to direct and coordinate that work and to get better results than if we postpone recognition and allow or require the extension workers to form an independent organization, or to affiliate with the farmers' institutes.

W. E. Stone. It is not quite clear to me what is the wisest course to pursue in this matter, and I only rise to point out some considerations which may help us to get a more comprehensive view of the situation. I think we all agree

that this extension work has come to stay in our institutions; come to grow and to occupy a very important place. At the same time we are all bound to recognize that at the present time it lacks organization and system. We do not know exactly what we are going to do with it. A large number of our institutions have not yet taken it up, so that it can not be said at the present time that extension work stands on anything like the same footing as does the station work. I am thoroughly convinced that there should be a place in our organization and in our proceedings for the extension idea and ample opportunity should be given for its discussion and presentation. Whether this should be in a separate section or be included, for a time at least, in the deliberations of the college section, I am not prepared to say. But a consistent attitude of the association would be to give liberal hospitality to this subject and this work in the college section for a time; then when it has developed into a definite form, if we are convinced that there should be a separate section, let it be made.

I want to be distinctly understood in my position, that I believe this work should have every encouragement which it merits in the association, but it was only a little while ago that the association believed that it had too many sections and divisions. There were, as some of you may remember, a large number of divisions of the work, and the results were unsatisfactory. Because of this condition the constitution was revised and after a good deal of painstaking study of the whole situation it was decided to have only two sections. Provision was made, as you will find by examining the constitution, for either of these sections to form as many divisions as it might wish, so that the way is quite clear at the present time, without changing our constitution, to welcome and properly care for this new work. This may be amply provided for by giving up a day on the program for the discussion of extension matters. I am sure we can not select any better general topic for next year's program than this. It seems to me the conservative policy would be to take some action of this kind for a year or two, until we see a little more clearly where we stand.

J. L. Hills, of Vermont. While I yield to none in my appreciation of what extension work is able to do for the farmer and am anxious to see it established in my own State, personally I feel that to give this movement, still in its infancy, a mature status in this body would be a mistake. One does not expect a child to occupy the same standing as that of a parent in the family. My personal judgment leads me to favor a subsection rather than the making of a new section. The constitution permits any institution to send any number of delegates. The college may send its president and likewise the head of its extension department, and these latter can, it seems to me, do as effective work for the time being in a subsection as in a section. Then, after a few years, when the movement has become thoroughly organized, if it then seems desirable, it can be accorded the dignity of a full section.

Furthermore, I raise the point whether, as the constitution now reads, this section if constituted should not be represented upon the executive committee. I query whether this association is ready to accord to the representatives of the comparatively new movement membership in this important committee.

K. L. Butterfield. Our committee did not discuss that point and nothing was said to indicate that it would be necessary to have members from this section present on the executive committee.

C. E. Thorne, of Ohio. There is a point that was briefly alluded to which I think should be considered in this matter, and that is that this extension work has already taken two thoroughly different lines, one of college extension and one of research extension, and in providing for future growth it would be neces-

sary to keep this in mind. These two lines of work are at present largely different and are likely to remain so and each will want its recognition in any new provision that may be made.

J. L. SNYDER. In our institution there are two lines of extension, the one carried on under the direction of the board as a part of the college work under the head of farmers' institutes, with a superintendent who is a member of the faculty. We have also a department of agricultural education, and one of the important functions of that department is to introduce the teaching of agriculture into our public schools and to carry on a home reading course. We have these two distinct lines of work, and just which should be represented in an organization of this kind I am unable to decide at present. I wish to call the attention of the members to a fact which seems not to have been emphasized, namely: This organization at present is made up of administrative officers—the presidents of the colleges and directors of the stations—and if we add this new section we bring in on equal footing subordinate officers. They are administrative in a certain sense, but subordinate to the members who are already in this organization. Whether that would be wise is a question. Many of you remember that years ago we had subordinate divisions. After discussing the matter for several years, it was decided that it would be better to have only sections composed of administrative officers. I think every one who has been a member of this association, both before and since that change was made, will admit that our organization has been much more effective since that change was made. The facts are that very few institutions will consent to send more than two delegates. I venture to assert that the record will show that the attendance has been as large since it was limited to administrative officers as it was before, and the more sections we add the more we weaken our organization. Now, understand me, I appreciate the greatness and value of this extension work. It should be organized; there is no question about that. The superintendents of this extension work should come together, but I think they should have more time than they could have as a section of this meeting. I believe they should organize separately and perhaps affiliate with the farmers' institutes; but I am not convinced of the wisdom of organizing another department in this association. It might be wise to organize as a subdivision of the college section, but I do not believe it would be wise at this time to form an independent section.

W. C. LATTA, of Indiana. While I agree with all the recommendations of the committee, I am myself inclined to approve the remarks of Professor Bailey and President Stone. The difficulties referred to by President Snyder would multiply as time goes on. This work is bound to grow, and the institutions which meet the demands of the people are bound to take care of it in some way, and the sooner the work is thoroughly organized and correlated, it seems to me, the better for the work and all concerned.

J. H. CONNELL, of Oklahoma. Twenty years ago at a meeting of this association we had half a dozen or more sections, and those sections, in my judgment, served a very useful purpose in clarifying and developing the work of the land-grant colleges during their formative period. I believe that much the same thing will probably result if we recognize this new feature of our collegiate work and give it a name and a place in the association. We are attempting extension work along so many lines that it is a confused mass, and the extension superintendents need to get their heads together and learn of each other. Anything that this association can do that will contribute to such a conference will be well worth while. From the standpoint of a State struggling to solve

this extension problem, I am ready to vote not only for a reference of this matter to the general body, but for its adoption.

E. DAVENPORT. I instinctively felt opposed to the proposition when I read on the program that a proposed amendment for a new section was to be considered, but I want to confess that the argument has won me over entirely to the other side, and I am going to vote for the new section.

K. L. BUTTERFIELD. I do not want to take up the time of the section, because the arguments have been brought out very clearly by those who have spoken so far. But I want to call attention to two things. The difficulties mentioned are recognized by the committee. We recognize that there is a certain anomaly, perhaps, in establishing a section of extension work when we have so few extension workers, and when the work is so new; and we recognize other difficulties such as President Fellows spoke about. But we feel that these are minor things that can well be swept away because of the larger interests at stake. There will be some conflicts. But the fundamental thing that we contend for is the recognition of the extension work as coordinate with these other two lines of work. That is the real heart of the matter, and that is the real reason why we are so earnest in presenting this question to the association. It has been suggested that we wait a little in order to see the drift of things. That is precisely what we do not want to do. We want to give to the present extension work the help that will come out of its recognition. It has been suggested that the administrative officers of the extension work will be subordinates; that may be true in some institutions as the work starts, but fundamentally the administrative officer of the experiment station is on precisely the same footing.

So, waiving these minor considerations, the question at issue really is, in my judgment, just what place we are willing to concede to the section work, as a growing phase, and a phase that is soon to be of the utmost significance, of the work of the land-grant colleges. We contend that the time is here when that recognition should be given. We admit that at first the work may be rather weak and the attendance may be small, but we believe that in two or three years after such a section is actually organized the work will be thoroughly on its feet. And nothing will do more to put it on its feet as a section and as a department of our work than the organization of a section. If that is done a large number of men will be here next year, and in future years that number will be larger; if not, I shall be very much disappointed. The committee feel that these objections, many of which are real, may well be swept aside in order to give recognition to extension work as coordinate with these two other lines of work. That is the question at issue. It should be decided now for the sake of the work of the college.

The recommendation of the committee that a separate section on extension work be formed was referred with approval to the general session of the association.

K. L. BUTTERFIELD. The second recommendation of the committee is one that was made a year ago and has not yet been acted upon by this section or by the association, namely, that Congress be requested to grant the franking privilege to bona fide extension publications. I may say in this connection that it seems to feel that this recommendation is in a sense attached to the general idea of a federal appropriation, but it is not necessarily so, and may well be discussed as a thing by itself.

The recommendation was approved.

K. L. BUTTERFIELD. The third recommendation of the committee is similar to that made a year ago, namely, that we state as the policy of the association that we are in favor of a federal appropriation for extension work. It is not in the minds of the committee that this is a propaganda that should be pushed with undue haste before Congress, but I think all of us feel that it is something that ought to be acted upon by the association at this time.

Your committee believes thoroughly that the Federal Treasury should be asked to assist in supporting extension work. We have already, by recommending the organization of a section, recognized what has come to be the common mind among us, I believe, that really this extension work is coordinate with the other lines of work. Now, we feel that it ought to be so recognized by Congress and by the public. The fundamental principle, as I understand it, of the Morrill acts and of the various appropriation acts, as the Nelson Act, is that of federal aid supplemented by state support. We ask that the same principle precisely be applied to this coordinate branch of the work of extension. It seems to us that it is a fundamentally correct position and argument. Furthermore, we think the time has arrived when it should be taken up because of the diverse ways in which the States are going at the work, and that the same things which have given us a certain measure of uniformity and standardization among the land-grant colleges, and in the work of the experiment stations will result from a federal act which defines extension work, and which immediately, in the public mind, gives it a certain scope and dignity. The work is important enough to have national character, national direction, national significance. We are quite aware that a good many States are taking up the matter, and it may be argued that they will all do it eventually. But I should reply that that is precisely the history of experiment stations. I am sure it would have constituted no valid argument against the Hatch Act, but rather would have been in its favor, to say that after twelve or fifteen States had organized experiment stations the thing was put upon a national basis and given national support, and that immediately the whole country was alive with research work. We feel that the same thing will come about here because essentially the same propositions are at stake.

In our outline of the proposed plan we are not at all tenacious about any parts, but have endeavored to recognize certain principles that we regard as sound. In the first place, we have suggested an appropriation of $10,000 a year direct to each State from the Federal Treasury. That is not a large amount, and it will immediately, when the bill is passed by Congress and goes into operation, put the extension work into every land-grant college in the country, and thus the whole work will be nationalized. Otherwise there will be a good many States that would not take up this work at this time. Further, this $10,000 will be ample to carry on the work in some States for several years. Then again, we suggest that the States which wish to carry the work further may do it by money from the state treasury, assisted from the Federal Treasury up to a certain limit determined on a per capita basis.

In reply to a question by J. L. Snyder, of Michigan, President Butterfield stated that the proposed bill had been framed with the idea that the funds were to be turned over to the college to be administered through the proper administrative officers of the college.

On motion the matter was referred to the general session of the association, with approval of the general principle involved in the recommendation.

The report of the committee as a whole was then adopted.

THE FUNCTION OF LAND-GRANT COLLEGES IN PROMOTING COLLEGIATE AND GRADUATE INSTRUCTION IN AGRICULTURE OUTSIDE OF THE COURSE OF THE GRADUATE SCHOOL.

H. J. Waters, of Kansas, presented the following paper on this subject:

The activities of the land-grant college have fallen into three principal groups, viz, (1) agriculture; (2) engineering and mechanic arts; and (3) domestic science.

These fields of activity are so diverse in their present state of development that it will be difficult to treat the institution as a whole in any concise way. I shall, therefore, confine myself to the problems relating to the agricultural group. This group has been subdivided into (1) extension, (2) special instruction, and (3) research.

Two or three decades ago the teacher of agriculture was only partially successful in attempting to apply his knowledge of chemistry, physics, botany, geology, etc., to the farm practice of that day. Then his knowledge of these fundamental sciences was limited and his acquaintance with the practices to which he sought to apply them was perhaps even more restricted and unreliable. Then the number of students was small and the demands from the farmer for information by letter, through articles in the agricultural press, and at the farmers' institutes were exceedingly limited. The chief problem of the college was to get enough students of a grade equal with the other departments of these institutions to make teaching inspiring.

At this moment the outcome of the enterprise projected on a national scale, by the passage of the Morrill Act, was filled with some uncertainty. These forty or more teaching institutions, brought into existence as a result of this act of Congress, in a period of the greatest agricultural expansion and development in our history, had not yet found themselves. The farmers were too busy bringing the fertile expanses of the West under the plow, and were too much interested in what sort of new machine for increasing man's efficiency on the farm would next be brought forth, to find these institutions or to be interested in them, whatever merit they may have possessed.

We can attribute, however, only a part of the meager support which the agricultural side of these institutions received from the farmer during this early period of their existence to his interest in other things and to his lack of appreciation of the value to him and to his children of the sort of education sought to be imparted. Any discerning student must recognize that the inherent difficulty lay in the institutions themselves, or, rather, in the lack of preparation of the men who were teaching the agriculture. Perhaps it is more charitable to say that the difficulty was in the subject itself, or, even more correctly speaking, in the limited knowledge which the world had of the subject at that time.

At this point, through the passage of the Hatch Act, an experiment station was established in connection with each of these colleges. Thus a research institution was united with a teaching institution. These teachers, having little else to occupy their time, began in earnest the study of agriculture through the agencies afforded by the experiment station, and while we are sometimes inclined to complain of the amount and character of the work thus far accomplished with the Hatch funds, yet considered as a whole, and especially in its relation to the teaching of agriculture, it is little short of marvelous in both quality and quantity.

One thing of fundamental importance soon came about—the teachers of agriculture of the country acquired as extensive and accurate a knowledge of the subject in its various phases as the farmer himself possessed. Added to this was his knowledge of the fundamental sciences, however limited, which gave to the teacher an advantage over the farmer in dealing with his business affairs that was immediately apparent and decisive.

At this moment, and for the first time, the agricultural departments of our land-grant colleges became effective and began to shape agricultural practices. In the meantime the prairies were put under the plow, and where a few years before had grazed herds of low-grade cattle or even wild buffaloes, presenting no agricultural problems, were now farm homes, fields of grain, and orchards. An agriculture under wholly new conditions of soil, climate, transportation facilities, etc., presented a thousand new problems.

Simultaneously with the practical exhaustion of the public domain came a rapid and decisive rise in farm land values, and the shifting of the whole great

agricultural problem from that of extension and expansion to that of conservation and utilization. Thus almost overnight it ceased to be a problem for the immigration bureau and the inventor of labor-saving machinery, and became one that could be solved only by the wisest economist and scientist.

The farmer's problems were shifted from the machine factory to the agricultural college.

So, suddenly, as though by magic, the agricultural teacher found himself in the very center of things; found his class room crowded with students, his mail filled with requests for advice, and demands for newspaper articles, feature stories in magazines, and calls to attend farmers' institutes and run educational trains, and conduct demonstration farms, in the aggregate far in excess of his ability to answer even though he devoted his entire time to this class of work. In other words, the situation had suddenly changed from a limited attendance of students and a special lack of interest on the part of the farmer to an attendance which taxed the facilities of the institution and an interest from the outside which was overwhelming.

The colleges have met this enlarged responsibility fairly and successfully, although in a manner that is wholly temporary. The last five years has been an era of expansion in teaching and in extension work comparable with the expansion in farming of two decades ago. The student has been held and made to do good undergraduate work, and the farmer has been reached through extension lectures, demonstration trains, leaflets, etc.

While all of this was happening and while the college was adjusting itself to its new relations and enlarged duties the experimental work and better grade of teaching have been permitted to suffer somewhat.

These recent years have been years of yielding to the pressure from the student and farmer for instruction and information, rather than in building up a sounder system of agricultural education and research.

In the last five years we have been traveling largely in a circle, or thrashing the same straw over again. We have been giving the world the benefit of the discoveries of science for the past fifteen or twenty years. That this is a duty which the college owes to the farmer no one questions for a moment, but to do this alone or even chiefly is fatal to progress. The farmer will soon catch up with the college teacher, and then all opportunity for leadership will be lost.

Happily, however, the colleges are rapidly catching up with the increase in students and are getting their extension work so organized that it need not seriously interfere with their other duties.

Just as the real progress which these colleges have made and just as all the real success which they have achieved were based on the researches of the experiment stations and the scientific bureaus of the world, just so will the future progress rest and depend upon even more rigidly scientific investigations.

While it is an admirable work to turn out young men trained for leadership on the farm and capable of going among farmers as teachers of the correct systems of husbandry, and to lead young men who come to the college to a better knowledge of the subject, after all the greatest work these colleges have to do is to equip men with the proper knowledge and the necessary inspiration to advance the world's knowledge and to supply these thousands of teachers with something to teach.

It has been a fundamental mistake to assume that the duty of the experiment station is solely or even principally to benefit the farmer directly. A larger responsibility rests upon it—that of making an exact science of agriculture, so that it may be successfully taught in the college, the high school, the grammar school, the farmers' institutes, and on demonstration farms. If the grade of instruction in the technical subjects is to bear comparison with the instruction in academic subjects, the teachers of agriculture must have better training than they are now getting. In the last decade the investigations conducted by these technical men, added to reasonably good teaching, has given them and their work high standing in the institution and abroad. We have reached, however, a period in our development where acceptable research can not be carried on with meager equipment and limited preparation on the part of the investigator. Likewise the quality of the instruction in agriculture will be more closely scrutinized and a higher standard will be required than heretofore. No greater fatality could befall the whole enterprise than for it to be placed on a lower plane than the work with which it is associated.

It is only by keeping the quality up to the best that is offered in other lines that the strongest students in our universities and land-grant colleges will be

attracted to agriculture. Any other situation will result in filling the agricultural class rooms with students of mediocre or inferior talents.

It is easy, however, to point out the necessity for better trained teachers and investigators, but the way to bring this about is not so simple.

It is now quite possible in our better institutions to enforce a rule for the classics, mathematics, pure sciences, modern languages, history, economics, and other academic subjects, to the effect that no one shall be appointed to a teaching position who has not received a master's degree, and that the door of even an instructorship shall be barred except to those who have won their doctorate. But anyone with experience in administrative affairs knows that such a rule would be wholly impracticable in the technical departments of our land-grant institutions at this time.

The truth is that until quite recently the main difficulty with the engineering schools, except the largest and except those which were located in cities, where a large consulting practice could be readily established, was to find men who would consent to teach at all. The demand for men in the practical field has been so insistent and the opportunities for a distinguished career so large that the stronger or more ambitious men and those especially of constructive ability have been attracted to the practical field, leaving the men of less intrepid temperament and men whose tastes leaned more to the academic life to do the teaching.

Similarly situated have the agricultural departments found themselves, especially within the last five or ten years. The call to activity outside of the college has been too loud and the salaries at which many of these men could begin their work have positively precluded the colleges and stations from holding them for positions of rank and emolument, much less for graduate study. As it now is, men begin work in the colleges and stations in agricultural lines, with the ink on their diplomas scarcely dry, at higher salaries than are commanded on the average by men with an advanced degree in academic lines.

The United States Department of Agriculture, in the era of unparalleled expansion through which it has recently passed, has, in self-defense, been forced to pay an astounding price for fresh graduates. Through this means many men have entered the government service poorly prepared and all opportunity to pursue graduate work has been cut off.

The outcome of it all is that the grade of teaching in these subjects is not being improved as rapidly as it is in other lines, and especially those lines in which there is less expansion and a less active outside demand for men.

Another force has been at work which, though almost imperceptible, has had a deterring influence upon the quantity of graduate work pursued, viz, the fact that the men in many instances who have pursued graduate work in agricultural lines have been among the weakest of the men turned out from the colleges—men who could not secure a position when freshly graduated, or had not the ability to hold a place when once it was secured for them. Each time these men would lose their positions they would drop into some institution for a year or more of graduate work, try another place, fail, take more graduate work, and so on. It has therefore not unfrequently happened that the poorest teachers and investigators were the men who had devoted the most time to graduate study.

Opportunity and responsibility, as already pointed out, have been crowding too hard upon many of the stronger men to permit them to do systematic work for which they would receive academic credit.

I have had strong students come to me to inquire if long and severe graduate work did not unfit rather than fit men for successful teaching and research in agriculture. Of course they failed to realize that no amount of study could take the place of ability and that the difficulty was with the man himself and not with his training.

THE CHARACTER OF THE GRADUATE STUDY REQUIRED AND WHERE IT SHALL BE FOUND.

At the present moment there is a very great difference in the practice of institutions with regard to the graduate work in agriculture. The two principal differences in the practice are as follows:

First, where the student in his undergraduate years receives his instruction in agricultural subjects with a moderate amount of the fundamental sciences such as chemistry, botany, physics, physiology, etc., and who for his graduate work takes more of such of these pure sciences as are more directly related to

the specialty which he has elected to follow. Thus, the student in animal husbandry will pursue courses in the university in evolution, embryology, etc., if his inclinations are in the direction of animal breeding, or take up a much more elaborate study of organic chemistry, physiology, physiological chemistry, histology, etc., if his inclinations were toward animal nutrition, and so on.

In a similar way the soil man would emphasize physics, inorganic chemistry, physiology, and geology, while the plant man would be interested in the advanced courses in the physiology and morphology of plants, in bacteriology, organic chemistry, meteorology, etc., and so on throughout the whole range of specialties.

It is true these subjects, or at least those which the graduate in agriculture would pursue for the first year of his graduate study, would not be ranked in the course of liberal arts and sciences, but have been usually classed for the agricultural student.

Another plan, not yet much in vogue because of the limited facilities of the colleges for giving graduate work, is to make up both majors and minors in the technical subjects.

The most common method, and the one which seems to be most generally acceptable, is to elect the major in the subject in which the student is to specialize, and to select his minors from the general science courses which are intimately related to these major subjects; thus, if it would be animal husbandry, with a specialty along animal nutrition lines, the major subject would involve the study of nutrition itself with the thesis based upon investigations in this particular line, while the minors might be along physiological or chemical lines, or a combination of the two.

It is a mistake to think that the colleges of agriculture of the country are not prepared to do good graduate work. The truth is, with the facilities at hand properly utilized, no other departments of our universities and land-grant colleges have such excellent facilities for the highest grade of graduate work. This is largely on account of the association of the experiment station with the college and the unusual opportunities that are offered the graduate student for high-class research in the line of his major subject.

The advisability of utilizing the experiment station facilities for graduate work might at first seem questionable. On a moment's reflection, however, it is apparent that any man properly prepared for graduate study would be able to take some special and detailed problem, one intimately related to some main investigation already being conducted at the station; one which through the investigations in progress is already well defined and outlined, and in two or three years' time work it out satisfactorily and completely.

Instead, therefore, of the colleges offering scholarships and fellowships for men to do superficial work along disconnected lines, let the graduate work be organized in a given institution along the lines in which that institution is especially strong and in which it is specializing, so that the theses will be real contributions to the complete and ultimate solution of the main problems under study. This enables the experiment station to secure the services of good men at little or no expense, and gives to the graduate student the material for work which the station alone would be able to supply. An illustration of this: At the University of Missouri last year, Mr. Moulton was registered for his master's degree, with his major in agricultural chemistry and his minor in animal husbandry. In the nutrition experiments being conducted by the experiment station there were a large number of samples of fat, selected from animals on widely different nutritive planes, of different ages, and from different parts of the body—all with a definite and important history. Mr. Moulton, for his thesis, was required to make a minute study of the chemical and physical properties of these fats, and in that way contribute in an important degree to the main problem under investigation. These samples of fat were incidental to the principal investigation, and had a man selected this study of the fats independently of the investigation being conducted at the station, it would not have been possible to have secured samples from animals with known histories, and from animals in which the other parts of the body were being equally minutely studied. In the one case his thesis was contributing to the discovery of fundamental principles, in the other the results would have had only a statistical value.

Another instance bearing upon the same line was that of Mr. Evvard, who was likewise registered for his master's degree, with his major in animal husbandry and his minor in physiological chemistry, and had for his thesis one phase of the behavior of the animals already referred to on different nutritive planes. He

was able to take one phase of the feeding problem under study, and at very slight expense secure data which the station could not have taken the time to secure, and which illumined the whole problem under study.

Thus, at every experiment station there are many such problems, too minute and detailed to take the time of the men in charge of the main investigations, but absolutely important to the final and complete solution of these problems, with which high-class graduate students can successfully deal. Moreover, offering such opportunities is the best possible way to secure students of this grade and to keep them at work until they have accomplished something of real merit, and have fitted themselves for a useful career as teacher or investigator.

THE COOPERATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE NECESSARY.

The colleges of agriculture and the experiment stations of the country can not successfully cope with this situation unaided. However much they may appreciate the value and importance of graduate study for men who are to take positions with them, they will not be able to hold the strongest and best of their students so long as the Federal Department of Agriculture is willing to put a fresh graduate into a position of responsibility at an initial salary of from twelve to fourteen hundred dollars.

I have no disposition to quarrel with the Department of Agriculture, for in the period of expansion and development through which it has just passed and out of which it is now perhaps emerging there was no alternative but to take the best men the colleges could supply and pay them such salaries as were necessary to command their services.

We have heard more or less talk of the Department finding it necessary to train its own men, etc.; that the men turned out from the colleges are lacking in preparation. The latter is conceded without question, but it is, of course, quite impossible for the Department to attempt to train men except to do a particular thing in a particular way, just as every college and station, and individual for that matter, finds it necessary to train a man for a special duty. Broadly speaking, the Department has no facilities for training men and must rely upon the colleges entirely for this work. But if the Department is to be able to secure from these colleges men that are soundly trained so that they will learn quickly to do the things which are required of them, and trained so that they will do them well, so that they will have sound judgment and will develop into strong investigators, it will be necessary for it to cooperate with the colleges and demand better preparation of their men before they are to enter responsible positions.

With the Federal Government taking a firm stand on this question it would be particularly easy for the experiment stations and the colleges to do the same, and to say to the fresh graduate that the door to appointment to responsible positions is through graduate study, and that the road to promotion and increase in salary, rank, and opportunity is through further graduate study.

Thus the duty to insist upon good graduate study does not devolve alone upon the land-grant colleges, but equally upon the Department of Agriculture, which has come to be the largest employer of the best men the colleges train.

For the land-grant colleges to fail to provide advanced courses of real merit, each institution along such lines as it has the men and equipment for, and to surrender all advanced work to men in pure sciences and in the universities, is to openly confess their own weakness or lack of appreciation of their largest opportunity for real leadership and a failure to realize their highest duty to the classes whose welfare they were created to promote.

L. H. BAILEY. I think it is really unnecessary to discuss this very suggestive and able paper of Dean Waters, since he has covered the ground so well, and since we probably all agree with his positions. There was a time when the public—on whom we depend for support—had difficulty in appreciating the value of even a four-year college course. The time is now coming rapidly, if in fact it is not already here, when the constituency of the colleges of agriculture are ready not only to grant the full four years' preparation in agricultural work, but also to approve two or three additional years. I find this sentiment to be growing among the farmers. They begin to feel that post-

graduate work is a necessity for young men who are to teach farmers. The whole character of the farming business has greatly widened in its scope in the past few years. Questions that formerly were asked of college and station men are now asked by farmers of each other, and they are able to answer these questions themselves. Now they want more knowledge. It is true, I grant, that much of the work for which students have received masters' and doctors' degrees (at least masters' degrees) in the colleges of agriculture has not been of the best character, and Dean Waters has very truly expressed the reason for it. A man who is incompetent, who is lazy, who is unfortunate in securing a job, or is merely weak, is likely to fall back on the college of agriculture and demand his right to a master's or doctor's degree, and to remain on for one, two, or three years. It was with this feeling that I was led to say last night that we must now exercise a selective process in deciding what men shall pursue postgraduate work in a college of agriculture. I do not think it at all follows that because a man has secured his degree of bachelor of science in agriculture he is thereby competent to be a candidate for the master's degree or the doctor's degree, because the institution, in giving a man a master's degree or a doctor's degree, put its approval on the man. It recommends him for station work and college work; in many cases it is for that reason that a young man pursues postgraduate work. It is the obligation of the college of agriculture to be very careful in its recommendations, just as careful when they are expressed in the form of a degree as when they are expressed in the form of a written letter or certificate. I would strongly recommend all heads of departments not to accept a student as a postgraduate unless they are satisfied that he has the postgraduate stuff in him. It is nearly always possible, when a man has graduated from an institution, for the instructors to form a fairly accurate judgment as to whether he has staying power, whether he has growth in him, and whether or not it will be wise to encourage him to expend time and money to take a postgraduate course. If the applicant has the postgraduate mind and the general ability and staying power, then of course the addition of the work represented by the master's or the doctor's degree distinctly qualifies him for work in the world. But, if he does not have the intellectual character, the addition of the second or third degree can not help him; in fact it may do just the reverse. The first point, therefore, that I wish very strongly to emphasize in commendation of this admirable paper is that we must begin to discriminate among candidates for postgradnate work.

What I had in my notes to say in this discussion was well said by Dean Waters—that each experiment station does become and must remain a medium to provide postgraduate work in the colleges of agriculture. I do not like to think of the experiment station in a college of agriculture as having a wholly separate and segregated existence. I feel that the men who are employed on the Hatch and Adams funds should not be engaged in teaching undergraduate work. I should prefer that the salaries should not be divided, and in our own case they are not divided. On the other hand, I would not eliminate all contact of students from the men who are supported on these funds. In our own case the men who are supported on the federal experiment station fund, whether Hatch or Adams, while they do no undergraduate teaching, have the privilege of taking postgraduate students, it being the understanding that these postgraduates are to be put into the work which those men or departments normally are doing as a part of their research. But they are under no obligation to take any particular number of men. The officer may accept one man or ten, depending on the facilities and the nature of work that is under investigation. Thereby

the experiment-station officer has the teaching contact, which I think is a very essential factor to his intellectual progress without the burden of the administration or having his attention divided by a great number of undifferentiated undergraduate students. I feel that an officer of the experiment station can very well be made the head of a department in a college of agriculture without at all really trespassing on the energy devoted to his research. I should like to see every department in a college of agriculture have at least three officers, one officer who, with his particular assistants, devotes his time to research, another officer responsible for the academic work, another responsible for the extension work. One officer will have the headship of the department. The general policy or theory of all the work is to be determined by the head of the department, or by a conference of these subordinate heads. Now, I see no reason why this head of such a composite or tripartite department should not be an experiment-station officer as well as a college officer. In fact, there are some reasons why he would better be an experiment-station officer. The head of a department is supposed to have his tenure of office comparatively undisputed; but if public clamor interferes with the tenure of any man's office, it is likely to be of the one who does not often appear before farmers' gatherings or who is closely engaged in laboratory research work. It is fundamentally important to laboratory research work that there be continuity of effort. Therefore, other things being equal, it tends to insure stability of investigation to place an experiment-station man at the head of a strong department. How much time such an officer shall give to administrative or extension work is wholly an internal question. I should hope he would give practically none to the details of it, but assign this part to one of the other officers; the officer, for example, who is responsible for the college teaching could handle all student administration, the general policy only being determined by the head of the department. It does not follow that these other officers would be subordinate in their rank as professors. I should like to see a dozen full professors, with full salary, in every department of college work if we could afford them; and it ought not to be difficult to avoid conflict of authority.

I am not arguing, however, for distribution of administration, but am merely trying to illustrate the fact that the experiment station can be articulated into the college of agriculture in such a way that it will become a real part of it and not at all interfere with the research or investigation work under the Hatch or Adams fund; that it will, in fact, rather aid the work, and at the same time constitute essentially a postgraduate organization or department. I would not eliminate postgraduate work from departments that are not founded in any way on the Hatch or Adams fund. I should expect every head of a department, if, in fact, not every man who is doing teaching in a college of agriculture, to prosecute investigation of some kind. If he is not engaged in investigation he really can not teach. But those who are engaged in research work should nevertheless not be cut off from touch with bright advanced students, and whose contributions, if carried out in the way in which Dean Waters indicates, will be a contribution not only to the postgraduate work in the college, but to the continuing constructive work of the experiment station itself.

My two points, therefore, are these: (1) That we should now begin to discriminate in the acceptance of postgraduate students, taking only those who, we have reason to believe, have postgraduate minds; and (2) that the experiment station can become in a very essential way a part of the postgraduate work of the college, without in any way interfering with its autonomy as a research organization.

The Function of the Land-Grant College in Promoting Agricultural Education in Secondary Schools.

E. A. Burnett, of Nebraska, presented the following paper:

The function of the land-grant college in promoting agricultural research and higher education is well defined and the lines of work fairly well established; but, while we nearly all agree regarding the obligation of the college to promote secondary agricultural education, we are not yet agreed upon the organization under which it shall develop. We all agree that research is vital to the promotion of higher agricultural education, and we freely acknowledge the debt which such education owes to the scientist, the experiment stations, and to the teacher who has collected and molded this scattered knowledge into pedagogic form, making it the basis of our present day agricultural instruction.

Broadly speaking, the colleges of agriculture have a vital relation to all those questions which make for agricultural progress. The college has made its influence felt through the experiment station, working out problems for the improvement of agricultural practice through students trained in agricultural science and through extension work in agriculture with the more progressive farmers. The 15,000 graduates now at work are its most effective missionary force; in fact, much of the present demand for the extension of agricultural education comes from the success already achieved by men who have had the advantage of agricultural training and have applied the teachings of agricultural science to farm practice.

The aim of most agricultural colleges very properly has been to offer instruction in agricultural science rather than in agricultural arts, and this has resulted in turning out a professional rather than an artisan class. The curriculum has been based on the theory that students could not begin the study of agriculture efficiently until they had at least an elementary training in all the sciences more or less related to agriculture. Under this theory agricultural subjects were placed largely in the third and fourth year of the course, which prevents any extended study of the subject without a postgraduate course and postpones the study of agriculture until a majority of those entering college have left the institution, so that they receive no benefits from technical instruction unless they have entered college as special students. Happily, this practice is rapidly being outgrown, and many agricultural subjects are now being taught in the first and second years of the college course.

It is granted that agricultural colleges serve but a few of the young men and women of any State, and that primary and secondary schools must furnish the only opportunity for the average boy or girl to secure an education. If education is to fit men and women for life, the public school should be made to serve the most important industries represented within its constituency, and to provide that class of education which best fits the pupil for his future duties and responsibilities. The basic industries of the country community have to do with the production of crops, the management of land and live stock, and the making of homes. A nation where 35 per cent of the people live in the open country, and where all classes are dependent on the prosperity of agriculture, should have a secondary-school system adapted to the needs of its constituents. The specially organized colleges can not adequately meet this need. Their courses of instruction are not fitted for boys and girls of high-school grade. The great mass of boys and girls never attend college. Graduation from high school ends their school days. The present high schools do not articulate with the agricultural colleges in a way which makes it easy and natural for the student to enter this college when his education will permit. The "trail from the rural school to the college of agriculture" is not easy to find. The high-school courses are shaped to lead to the college of liberal arts, and this college stands waiting with extended hand, so that the boy who turns away from it to enter the college of agriculture must have a well-defined purpose in his mind before he starts to college. The agricultural high school would point the way and blaze the trail to the door of the college of agriculture and bid the student enter.

A distinctively modern idea in education is that it shall have a definite aim and purpose; not that all education shall be technical or professional or be purely commercial in spirit, but that it should specially fit the person for the particular life he is to live. It shall enable him to contribute to the uplift and improvement of life in general and to his special field in particular. The great need of the educational system of the United States to-day is a proper develop-

ment of the technical schools in agriculture and manual training—agriculture, because it engages directly so large a proportion of the people and is responsible for the food supply of the nations; manual training, because practical training in the shop gives manual skill, which is useful to every man engaged in industrial pursuits. Quoting from the Assistant Secretary of Agriculture, the Hon. Willet M. Hays: "The schools which to-day are dwarfed as compared with the functions they have to perform are those secondary schools or people's colleges which lead to the industrial vocations where large numbers are to be accommodated.

"It should be clearly recognized that the types of primary, secondary, collegiate, and graduate school to make a well-formed American educational system are all present, and that the weakness of the system is quantitative. * * * The need of the hour is to build up the industrial vocational courses in our system of secondary schools."

The recital of what has already been accomplished or is in progress indicates a strong popular demand for secondary agricultural education. Quoting from "The American System of Agricultural Education," published by the Office of Experiment Stations, Circular 83, 1909 (copies of which are doubtless available at this meeting): "In the effort to meet the needs of the various classes of students, especially those who are unable to complete a full college course, the agricultural colleges have been unusually active in recent years in organizing short and special courses of different kinds. At least 52 of these institutions have organized such courses." A more detailed statement of some of these schools will be presented later.

But in spite of all these things done and in process, there is still "the agricultural problem"—the problem of universal application of agricultural knowledge; for the agricultural problem will not be solved until every man who lives upon the land has a knowledge of the fundamental laws of production relating to his business and manual skill sufficient to become a high-class artisan. So long as the land-grant college stands as the exponent of agricultural progress, it can not free itself from the responsibility of directing the lines along which progress is made. The problem, so far as it affects the mature farmer, is one of agricultural extension—the carrying of agricultural knowledge to all the people. So far as it affects the boys and girls of to-day, who will shape the policies of the future, it is a question of primary and secondary education. We should endeavor to work out the problem of secondary agricultural education in the same conscientious spirit which has prompted our early efforts in higher education, and if it be found that the responsibility for such education rests equally with the departments of public instruction of the several States we should still lend our best efforts to the extension of agriculture into all secondary schools which serve a rural constituency. It is surely the function of the agricultural college to foster so far as possible all those agencies which make for better country schools, more intelligent use of the land, and for a society better organized to upbuild the open country.

The student who is able to afford only a brief period of schooling in which to get some practical knowledge of farming to apply in his business and must then return to the land and put this knowledge into practice can not spend a large amount of time studying the natural sciences as a prerequisite to the securing of agricultural knowledge. He must begin with practical subjects and confine his study to such phases of those subjects as are adapted to his degree of education and mental development. Laboratory courses in stock judging, grain judging, dairying, horticultural practice, and many other subjects are not based upon science so technical as to delay their place in the curriculum beyond the first year of any college or university, nor in fact beyond the second or third year of an agricultural high school. These subjects seem to me more suitable and better adapted to secondary schools than to college work, and under a correct system of secondary education they would be transferred largely from university studies to the agricultural courses in secondary schools. The elementary principles of cultivation, of soil fertility, and crop rotations may be taught effectively to students of the tenth or eleventh grade, and no proper system of rural education will omit this instruction, since to do so deprives 90 per cent of the farm boys of receiving any instruction in these subjects which are so vital to rural progress.

There are, I believe, but two methods proposed for the extension of secondary agricultural education, namely, by enlarging the work of the present high schools to teach agricultural subjects and by the establishment of separate agricultural schools covering rather large districts, where agriculture and

domestic science may be taught, together with such academic subjects as are necessary to the rural high school.

Whatever the organization of these schools, it is essential that the agriculture should be thoroughly taught and that the courses offered shall form a sufficient part of the curriculum to make the subject of real economic value to the pupil. Secondary agricultural schools, to make any impress on the student, must make agriculture a dominant feature of the school and secondary to no subject except the English language. Not less than one-third of the course should be technical, relating to rural life; about one-third should be given to natural sciences, and the balance to the ordinary academic subjects. All of these subjects so far as possible, should be taught by laboratory methods or by actually doing the thing itself.

While many high schools are making an effort to teach agriculture, I know of none except the specially organized agricultural schools which have been able to offer a sufficient amount of agriculture to give it value in farm practice. This is not necessarily the fault of the teachers nor of the officers, but is due to the organization under which city schools have developed and from which they can not easily change. In nearly all States the secondary school has been built up to correlate with the literary courses of the university, and this system has become so thoroughly established that it is difficult or impossible to make any radical modification of this sytem.

Unless conditions are very greatly changed, it will be a long time before an adequate system of agricultural education can be introduced into the average city high school. The courses of study in these schools are strongly literary or mildly scientific. The agriculture taught is valuable as a culture subject and in establishing a liberal point of view toward agriculture and the industries. It is, in fact, a beginning in the modification of our school system to meet the needs of our present industrial life and as such it should be commended, but it is so far short of filling the needs of rural communities that it can not be looked upon as a solution of the problem.

The present cost of secondary education is as great as the average community is willing to support by local taxation. To endeavor to introduce courses of study in agricultural lines requiring expensive equipment, laboratories, and teachers would practically double the expense and place it beyond the resources of the average county or district. It therefore seems apparent that either the district of the agricultural school must be made larger than the average county or else this school must be supported partly by some outside resources, either private, state, or federal.

The school which endeavors to teach agriculture by the introduction of a single teacher who is also expected to give instruction in natural science, will not meet the demand of the present day. This demand is for technical instruction of sufficient amount to be of practical use in farm operations. Five hours of instruction for one semester in a four years' course is entirely inefficient for this purpose, and yet this is all that is thought feasible by the best high schools in the State of Nebraska. It is manifest, then, that in Nebraska either the possibilities for agricultural instruction must be enormously increased in the established high schools or some system must be established having a larger unit from which to draw support and offering a more favorable environment for the introduction of agricultural subjects.

If the secondary schools afforded an opportunity to study the subjects which relate to the arts of life, rather than forcing the boy to study foreign languages and higher mathematics in his preparation to be a farmer or a mechanic, many young men would be found in these schools to-day who at the age of 14 or 15 are now found in the industries or without occupation. Lacking this opportunity, many boys drift into the unskilled class, leaving the land because it holds out no promise for advancement and entering the trades to compete with the lowest class of labor. Through technical schools for the education of the young, thousands might be taken from this unskilled class and trained to become efficient in the industries. Every boy who is thus taken from the ranks of unskilled labor and transferred to the artisan class not only becomes a more efficient economic unit, but reaches a higher standard of citizenship, adding wealth and influence to the community and stability to the nation.

President Roosevelt, in his address "The man who works with his hands," said:

"We hear a great deal of the need of protecting our workingmen from competition with pauper labor. I have very little fear of the competition of pauper labor. The nations with pauper labor are not the formidable industrial com-

petitors of this country. What the American workingman has to fear is the competition of the highly skilled workingman of the countries of greatest industrial efficiency. By the tariff and by our immigration laws we can always protect ourselves against the competition of pauper labor here at home; but when we contend for the markets of the world we can get no protection, and we shall then find that our most formidable competitors are the nations in which there is the most highly developed business ability, the most highly developed industrial skill, and these are the qualities which we must ourselves develop."

Few high schools serving rural communities are in position to offer more than one course of study, and much less to become pioneers in establishing agricultural courses requiring expensive equipment and high-salaried teachers. It is manifestly true that if agriculture is to be put, by a gradual process of evolution, into all the high schools serving rural communities, many schools must begin now to work out this problem, while much energy will be lost in trying to foster agricultural instruction in an environment which is not in sympathy with it or under conditions which are not favorable to its success.

It has been said that the greatest difficulty in introducing agriculture into the graded schools is the lack of efficient teachers. It might also be said that the demand is not uniform and the conception of what instruction is required is varied and vague. There are 100 high schools in Nebraska offering four-year courses of instruction and about an equal number offering three-year courses. Our best high schools are trying to offer five hours of agricultural instruction in a four years' high school course. Should it be proposed to increase this instruction to twenty hours in these schools next year, or five years hence, it would be considered impractical from the standpoint of the schools, and if put into operation would probably do infinite harm in disorganizing the present system without successfully introducing agriculture; yet five hours per week, or a total of twenty hours, of agricultural instruction throughout the second and third years in these schools would offer very limited opportunities to the boy desiring an agricultural education. If a generation is to be taken in making this change it could doubtless be accomplished, but even then it would seem that a few properly organized schools to work out the system would soonest accomplish the result. We will learn how to operate agricultural schools by doing it, working out the system in a few schools in every State, and may then take up the question of its extended application. Happily there are now a number of agricultural schools in the several States where this system may be studied and its efficiency determined.

These schools should be strictly secondary schools, in which the agriculture taught would be suited to the high school grades and not to college grades. It will be necessary that the district should be large enough to support this school by taxation, for, though the Federal Government may some time come to the aid of such schools, there should be no hesitation on the part of the State in establishing agricultural schools if they are based upon a correct educational policy and are efficient in proportion to their cost. Such schools will be worth all they cost in working out the problem of agricultural education and adapting it to the needs of other secondary schools. Much of the cost of one or two such schools might properly be charged to the State at large as furnishing an opportunity to develop a school suitable to further extension in rural communities. A bill was presented in the last Nebraska legislature to introduce agriculture and domestic science into twenty high schools in the State. This bill carried an appropriation of $100,000 for the biennium, or $2,500 annually per school. This bill failed to pass. It is to be hoped that when finally passed the bill will provide an equal sum to be applied to five high schools, working out the problem on the basis of about $5,000 annually for each school for salaries and maintenance in addition to equipment and permanent improvements. This agricultural school will give instruction concerning the things with which the farm boy and girl are familiar from childhood. It will teach handicraft by doing things on the land or in the shop or laboratory. It will teach of the neighborhood life and industries and the practical application of this knowledge. The utility of this knowledge will hold many boys in school who, because they now lose interest in the classical and literary studies pursued, drop from school without sufficient training to enter the trades or to become skilled artisans.

There are in Nebraska about 300,000 pupils of school age in attendance at primary and secondary schools. From 15,000 to 18,000 of these are in the secondary schools, and a very much smaller number are in attendance upon colleges and universities. Of the 15,000 it is fair to presume that 40 per cent come from the country, and that an equal number will return to the country.

What would be the economic result if these 6,000 boys and girls could receive good instruction in agriculture and home economics and perhaps 1,000 of them return annually to Nebraska farms to put into practice the improved methods taught in the schools? If the results achieved were commensurate with the results of the present university school of agriculture, it would not be a generation before the demand would be overwhelmingly in favor of agricultural schools in every rural community, and production and profits from the land would be increased almost beyond computation.

The Nebraska School of Agriculture offers a three years' course of instruction. It is in session for only six months of each year, beginning in November and closing late in April. It accepts pupils with eighth-grade county certificates and also from ungraded schools, provided they have sufficient age and maturity. It receives many boys with one or two years' high-school training, and frequently has college graduates enrolled in its shorter courses. The schedule for men requires 109 hours' recitations and 45 laboratory periods, each covering one-half year. Of the 109 recitation hours and 45 laboratory periods required, 44 hours and 30 laboratory periods are devoted to technical subjects, 27 hours and 11 laboratory periods to scientific subjects, and 38 hours and 4 laboratory periods are devoted to academic subjects. The course in home economics devotes 22 hours and 28 laboratory periods to technical subjects, 24 hours and 14 laboratory periods to scientific subjects, and 46 hours and 4 laboratory periods to academic subjects. It will be seen from a study of the courses offered for boys that this school is rather severely technical, but it meets the need for a secondary agricultural school in the region where it is located, and offers instruction infinitely superior to a regular high-school course for young men who expect to become farmers and are unable to secure a college education. These courses are arranged with the idea of preparing young men and women to go back to the land rather than to enter the university. It is possible, however, for graduates to enter the College of Agriculture. The school, being in session but six months of the year, is adapted to young men who are required to work on the farms during the growing season. It is not well adapted to young men who do not need to spend the entire summer upon the land, and for whom a longer school year should be provided. If sending back to the fertile lands of the Commonwealth a few young men and women trained in agriculture makes for progress beyond the old academic system, it is proof that a much larger number should have advantage of this education, either in one or in several secondary schools.

There are several types of separate agricultural high schools receiving state aid, chief among which may be mentioned congressional district agricultural high schools and county agricultural high schools. Alabama and Georgia may be mentioned as chief among the States which have established schools in each congressional district. Alabama appropriates $4,000 annually and Georgia $7,500 annually from the State to each school for maintenance.

The Wisconsin plan may perhaps be taken as typical of the county agricultural high school. These schools are equipped at the expense of the county, but receive state aid to the extent of $4,000 per year for each school, to be applied to running expenses. Four of these schools are now in operation in Wisconsin. The course of study in each extends over two years, and includes work in soils, plants, animal husbandry, rural architecture, blacksmithing, carpentry, and mechanical drawing for boys; cooking, laundering, sewing, floriculture, and home management and decoration for girls, besides English, United States history, civil government, and commercial arithmetic for both boys and girls.

California has established two secondary schools after the type of Minnesota and Nebraska, and Massachusetts has three or four such secondary schools. Several other States have secondary schools in operation conforming in type to some of the classes above mentioned.

The proper atmosphere for agricultural education can be secured only where the instruction offered is sufficient in amount to make the course strictly agricultural, where the equipment is adequate to give thorough instruction, and where the teachers are competent and enthusiastic. These conditions can be obtained only by the expenditure of considerable sums of money for laboratories, land, and equipment and by the payment of salaries adequate to command teachers specially trained along these lines.

The secondary schools in agriculture which have been established in connection with some land-grant colleges, as in Minnesota and Nebraska, have been an unqualified success. They can hardly be used as a type for the agricultural high school which is to be duplicated several times in a State, since

they have available equipment and teachers far in advance of what would be possible at a district agricultural school; nor can the results which have been obtained in these schools be taken as typical of the results which might be secured in schools of lower grade. They do, however, include all of the features which would be required in this smaller agricultural school. Such a school would endeavor to give only two or three years of agricultural instruction. Most pupils finishing this school would return direct to the land, but a portion of them would enter the land-grant college or possibly continue their agricultural studies in the secondary school connected with such college. The college could materially strengthen its work along the lines of agricultural science by transferring secondary subjects to its secondary school.

We are agreed that any secondary agricultural school must teach a number of academic subjects in a thorough and systematic way. It would seem feasible that these agricultural schools, where not attached to agricultural colleges, should be located in connection with some already established high school, where the academic studies could be taught, rather than to duplicate teachers and administration by establishing an independent school. It must be possible to find in every State many high schools serving country constituencies where the atmosphere is favorable to the development of agricultural education and where schools of agriculture could be joined to or affiliated with the high schools already established. This would do away with the objection that the agricultural high school is a narrow trade school. It would prevent the duplication of academic subjects necessary to the maintenance of entirely separate schools. It would ally the agricultural high school with the present system of education, preventing the development of two independent educational systems. The board controlling such schools might be organized as in the agricultural high schools established for judicial districts in the State of Oklahoma, where the president of the agricultural college, the superintendent of public instruction, and the president of the body governing the land-grant college make up the board of control, with a dean appointed to supervise all the schools of the State established under the act. It is, in my judgment, essential that the land-grant college shall supervise the agriculture taught in agricultural high schools and become responsible for the instruction offered in order that this instruction may reach the highest degree of efficiency and practical application.

It is important that we consider the effect of establishing these schools on the support for higher agricultural education. The average citizen values practical education more highly than theoretical education and the results of applied science more highly than the science itself. Many institutions of higher learning are to-day struggling for sufficient funds with which to carry on their work in higher education, and few are abundantly supplied. If the establishment of a severely practical agricultural school in every ten or fifteen counties will operate to lessen the support to the land-grant colleges by bringing the agricultural school to the foreground and discounting the worth of agricultural science and general education, this move will not be an unqualified good, and land-grant colleges will generally oppose the system, throwing the burden of extending secondary education onto other shoulders and endeavoring to aid only by furnishing the teachers who are qualified to fill these technical positions, since it must be granted that the lack of qualified teachers is one of the great handicaps to the rapid extension of secondary agricultural education.

It would seem that the land-grant college can not do less than to provide for one thoroughly equipped secondary agricultural school under its own supervision which will furnish systematic instruction to those who apply for it. This school will afford the opportunity for a study of the best agricultural practice and of home economics to those who have neither the time nor the previous training to acquire a university education. The college should make a clear distinction between higher and secondary instruction, and in its secondary school should arrange its courses to fit the student who desired to return to the land, rather than make this school primarily a preparatory school for entering the college or university. A few who are specially fitted to continue their studies will enter the college courses, but the majority will go back to the farm to make an educated constituency on the land, which is, after all, the purpose for which the agricultural college was established.

There exists to-day a great reservoir of agricultural knowledge awaiting distribution through agencies which will reach the agricultural masses. No one agency will be sufficient. The college of agriculture must furnish the leadership for this movement. The secondary agricultural school must be organized to reach the young men and women in the open country before they have turned

their faces cityward. The extension movement must reach the farmer and prove the efficiency of agricultural science to multiply the fruits of toil. In this leadership the land-grant college must not wait for the people to demand progress and improvement, but it must be bold and progressive and must blaze the trail. So shall we establish the vital union between agricultural education and rural progress.

E. DAVENPORT. In my experience and observation no single question comes quite so close to agricultural-college people right now as this matter of secondary education. To be sure, there is a demand on the part of the public that agriculture shall be taught in the schools, and there is a feeling on the part of all of us that it ought to be. We all have come to the conclusion that agriculture can be taught in schools of secondary grade. When I was a student in the Michigan Agricultural College, that abstruse and philosophic subject known as psychology was reserved to the last six weeks of the course. Now we are talking about putting it into the high schools, and I am not certain but it belongs to the grades. As Professor Burnett says, we have learned at last that the student does not require preparation in all-around science and literature before beginning the study of our subject, and I believe it is considered good pedagogy in these days to begin at once the study of any subject which attracts the attention of the student. Now, the most aggressive element in this whole matter, as I see it, is not the farmer nor the agricultural-college man, but it is the school-teacher, and he puts up to you the question, "Can we teach agriculture in our schools?" We must tell him yes or no—one of the two. We must say to him, "Yes, sir; you can, if you put money and brains into it;" or else tell him "You can not do it successfully; we must keep it out of the schools and we must have another set of schools for that work." Right there we are at the turning point of the whole situation. The reason for it is that the high schools are scared nigh unto death. They are scared for several reasons. One is that the boys are leaving them. For ten years the high-school principals and superintendents have been wondering how to keep the boys in school, for as technical schools have appeared in different parts of the State they have attracted the country boys. They know they can not keep the boys unless they put in vocational studies, and they are afraid of the technical schools coming up by the side of them. Now, unless the American high school does put in not only agriculture, but other technical and vocational courses, and unless the American high school at once is ready and willing to devote at least a fourth of its time to vocational purposes, not simply industrial, but vocational in general, then the American high school is doomed, because the American youth is bent upon technical vocational training. He is going to have it, and his father wants him to get it and it is in the air. In other words, the high schools of the United States to-day are at the turning point, and they must retire from the old position of the academy whose business it was to prepare for the literary college. They are ready to do the new thing, and we must help them. I have in mind now a high school with a thousand students and seventy-five teachers. The principal put to me this question: "Shall we put agriculture into the high school or not?" I said, "Well, suppose you do not put it in, then what are you going to do?" He said, "That is just the point: there is no can't about it; we have got to do it, and, as I see it, each high school has to put in a department of agriculture." That same high school is to-day a bigger institution in every sense of the term than was the University of Illinois fifteen years ago. I have in mind a little high school situated in a little country community. That agricultural high school undertook to prepare for our colleges and universities, but it gave four years to agriculture, and the high-school visitor says that no better science was taught in any high school in the State of Illinois than was taught in that school. The experience of Minnesota last winter is significant. They fought out this question up there, and passed a bill providing that the first ten

high schools of the State which would introduce agricultural departments that would meet the requirements of the state board of agriculture should have a bonus from the State of $25,000. When the bill passed 65 of the leading high schools of Minnesota applied for its benefits. Of course only 10 could be admitted, but many of the others arranged at once to attempt the work, with the hope, of course, to get in on the next bill.

Now, this means putting agriculture into the existing high schools. It means a new department in these schools, and that is all. What we mean is to put agriculture into the high school nearest to the boy, so that he can go there in the morning and come back at night. That is our job, to get secondary agriculture within walking or driving distance of the boy when he is 12 years old; and most boys get their trend in life before they are 17. We can not take them too young to make good farmers, and it will not do to let the city high schools have the management of these boys until they have passed high-school age and then put them into some school a long distance from home.

If we had not had the advantage of fifty years' experience the problem might be different. If the attitude of the educators of the country to-day toward agriculture were what it was fifty years ago, we might be obliged to establish separate agricultural schools in order to convince them. That is what we had to do with the colleges of agriculture. Michigan Agricultural College was a pioneer, laughed at by everybody. It had the job of making agriculture respectable and respected. If the attitude of the universities of America had been toward agriculture in the forties and fifties what it is to-day, we would have never needed a separate system of agricultural colleges, and we should all have been further ahead. That is simply a matter of opinion, but I believe agriculture to-day would have been many years ahead of what it is now, and so would educational standards generally, if we had made the same kind of a hitch-up in 1850 and 1860 that we can now make and are making between agriculture and all other subjects of instruction.

With that experience behind us, with the attitude of educators what it is to-day, practically confessing, and not only confessing, but tumbling over each other to show that all education must be partly vocational—I say, with that attitude of educational men to-day it is simply folly to talk about going outside of present organized systems of education to get results. All that is necessary is to do a little organizing and a little hard work, provide teachers, and then leave it to the high schools themselves. To provide teachers is the great work of the agricultural colleges. I tell you to-day the move is back upon the agricultural college. If we will do our part and do it promptly and effectively, the high schools of the country will do theirs. They ask: "Can you furnish teachers and tell us how to do it?" Now, that in general is the sentiment of secondary school-teachers in the country. There are, of course, some exceptions. We have to tell them one of two things. We can say, "You can do this," or else "You can not do it; it is too much for you." I do not want to say to the high schools, "It is too much for you." I propose to say, "You can do it if you will." If the high schools do not meet this question inside of five years, they will find themselves reduced to girls' schools in the cities and to schools preparatory to college.

How Can Agricultural Colleges Best Serve Farmers in Solving Rural Problems?

E. J. Wickson, of California, presented the following paper on this subject:

Obviously the best and most fundamental service which the colleges of agriculture can render consists in learning the character and solution of the real rural problems and in teaching what they are and how to solve them.

As the executive committee in assigning this subject to me did not accompany it with limiting specifications, I might easily seize the chance to indulge in definitions, analyses, and arguments about rural problems and their treatment, or I might select a few rural problems and knock them out "while you wait" and thus afford a demonstration of method. Careful study of the subject as stated for me by the committee convinces me, however, that it is not intended that I should attack rural problems nor make any suggestions as to the relative efficiencies of their various solvents, and this reflects credit both upon the wisdom of the committee and upon my own insight into their intentions, because no one yet needs to be reminded that the Country Life Commission has a stock of rural problems and solutions duly arranged in order of magnitude and all connected backward with their contributory causes. I have heard only one objection to the commission's collection of causes and effects and that is that they are not new. The triviality of that objection becomes perfectly clear when one thinks of the objections which would have been set up per contra if the commission had brought forward a lot of problems and remedies which no one had ever heard of and therefore knew nothing about.

What can I say, then, of our agricultural problems? Evidently I am moved beyond speech and can only shout, in paraphrase of the eloquence of the old Bay State patriot: "Mr. Chairman, there stand our agricultural problems; look at them."

And having been excluded from the enjoyment of discussing rural problems as such, the question assigned to me seems to present another limitation, for it apparently contemplates only service to farmers in solving rural problems. We have become quite accustomed to the idea that solving such problems was at least a patriotic national service, and possibly even a world-wide service. If I am not mistaken, very much of our recent remarkable progress in agricultural science which has elevated farm practice, and in agricultural economics which have exalted farm enterprise, and in public esteem which has modified the attitude of all those engaged in other callings toward farm industry, has been due to the recognition of the advancement of food production as not alone a problem for farmers but for humanity. I am therefore disposed to contend that our agricultural colleges should not be satisfied with a limitation of their scope and purposes, which is unintentionally, doubtless, implied in the phrase "serve the farmers in solving rural problems."

I am not forgetful of the apothegm of the fact "who would be free, themselves must strike the blow," and I trust that principle will be used to the fullness of its hortatory force, but we all know, of course, that if no blows had fallen during the last quarter of a century except those which farmers themselves have struck, agriculture would not occupy the advanced position in the understanding of its own materials and methods, and in the public mind as a progressive industry, which is now freely accorded to it. Therefore I am disposed to claim that as agriculture is unquestionably entitled to all the recognition and all the promotion it can secure from statesmen, and from those engaged in professional and in all industrial activities, educational effort toward the solution of rural problems should never for one moment be restricted to or measured by "service to farmers," and the question then becomes simply: "How can the agricultural colleges best serve in solving rural problems?"

Having thus expanded my subject without consent of the committee, it is only fair to the committee that I contract the discussion of it correspondingly, and to this end I indulge in a category:

First. It is the duty of the colleges to undertake research to disclose data for the better understanding of rural problems and to teach all sound learning connected therewith.

Second. As true solutions of these problems affect all interests of mankind and underlie all successes therein, it is essential that they be treated not alone as class affairs but with due understanding of their relations to the prosperity and happiness of all classes.

Third. It is therefore desirable that separate colleges of agriculture should make effort to broaden their instruction in such subjects as economics and social science to the end that their pupils shall have presented to them not only "agricultural economics," so called, but should be given fully and fairly the points of view of commerce, manufacture, transportation, etc., so far as possible.

Fourth. It is also desirable that all colleges of agriculture which are integral parts of universities presenting economics and social sciences in other departments should insist that these departments qualify themselves for research and

instruction which shall embody the agricultural point of view, and do this work not alone for the edification of agricultural pupils who elect their courses, but because it is intrinsically valuable culturally, and because it is important that all citizens should be aware of the nature of an agricultural point of view and its importance in the settlement of economic problems, which has been thus far chiefly approached from the points of view of commerce, manufacturing, transportation, etc.

Fifth. As it will be, perhaps, conceded that research and instruction in the sciences and arts of production have brought the farming interests to a producing ability greater than their ability to move and market products profitably, it should be the duty of the colleges to manifest serious appreciation and earnest activity in solving problems of the latter class and to plan for new and broad effort in that direction.

We return, then, to the starting point—that the most fundamental services which our institutions can render is to understand rural problems and teach what they know. Two questions arise—how to provide for research and how to conduct instruction. Both are difficult to answer. The second question is particularly difficult, because the subjects are not only obscure and complex and hard to differentiate from the forbidden and closely allied subject called "politics," about which every citizen considers himself the best, as he actually is the ultimate authority in the choice of his own opinions and actions. In advancing agriculture the teacher of agriculture has to demonstrate the superiority of his knowledge to that of the old practical farmer who operated by tradition and moonlight as recorded in the "farmer's almanac," and so the teacher of economics from an agricultural point of view must demonstrate to all fair-minded people that he knows more than the visionary who honestly "has opinions as hold to reason," and vastly more also than the demagogue who cares neither for honesty nor reason. Still the undertaking must be made both in regular college courses and in extension work. It will require masterful and ready men and should not be entered upon without them, at least on the extension line, where "talking back" is generally invited.

To provide for the research which will enlighten rural problems will chiefly require funds. There are many higher-degree men now issuing from our universities who have had thorough training in the methods of inquiry and demonstration in economics, and many of them have had experience in rural life which will enable them to appreciate the nature and importance of the work which is needed from them. The best of them will become the teachers who are required. It seems desirable, then, that the problem should be first attacked upon the research side, and whence shall the funds be derived?

I hesitate to make a suggestion which I have in mind, because it is against all the traditions and may possibly be capable of sharp denial. Still I am impelled to proceed upon the strong conviction that the truth which our agriculture now most urgently needs is not to be gained by extending investigations in the physical sciences nor in the application of the results to agricultural practice, though both are desirable. In my own State they are being increasingly provided for by state appropriations. Such researches as are now needed in rural economics and social phenomena are not likely to be provided for by the State, and they are properly a national provision.

Are the Hatch and Adams funds available for such researches? They would meet the requirements of section 1 of the Hatch Act, for they would yield "useful and practical information on subjects connected with agriculture," but section 2 of the Hatch Act undertakes so many specifications along lines of physical science and agricultural practice that the inclusive phrase "and such other researches and experiments bearing on the agricultural industry" must be taken perhaps to mean something else of the same kind. Although the Adams fund is declared to be for the more complete endowment and maintenance of stations now established under the Hatch Act, its provision for "original researches or experiments bearing directly on the agricultural industry" is not connected with physical phenomena so closely, and, for all I know, may be employed for economic and social researches "bearing directly on the agricultural industry."

However this may be, it is clear that the answer to the question submitted to me is that the agricultural colleges can best serve in solving rural problems by underaking such researches and by maintaining in all lines of teaching, in the college classroom, in extension efforts, and by publications, the truths which such researches shall disclose.

J. H. Worst, of North Dakota. I can see that, perhaps, if the section had taken different action on the subject of college extension, there might be an opportunity here to say considerable that would be of interest. But the action which the section has taken renders it unnecessary. To my mind the college that is earnestly endeavoring to meet the needs of the community will find a means through that channel of serving the farmers of the open country. Now, being a hereditary farmer myself, it looks to me a good deal as if in all these sessions we are undermining the old-time farmer—the hereditary farmer. But we may say what we please, for him or against him, he has been in existence a long time, and he has made a splendid record. He has fed the world and furnished raw factory material since man inhabited this planet. He has got his traditions, his peculiarities, his notions, and we are simply destroying all these and building up a different sort of farmer. I do not know but we can make a good deal better one, a more scientific one, and I think the world needs it.

I can not quite agree with Professor Carpenter in his magnificent optimism, that as these great problems come up we are going to be sufficiently ingenious to meet them and cope with them successfully.

I like optimism, but it seems to me that the time has come when our agricultural colleges and all the influences that can go out from these directors and teachers should be on the side of conservation and economy. One of the great problems which this old-time farmer is confronted with to-day is, What shall he do with his boys and girls? He does not like to send them away to school because he knows, or he has observed in the past, that it takes them away from the land. I remember years ago traveling teachers used to tell us if we were bright boys and attended strictly to our work, we would not have to be farmers. We look upon agriculture now as quite a different thing from what it was twenty-five or thirty years ago, and it is destined to become the great profession of the future; there is no question about that. Now, we must learn to know the farmer; we must learn to know his traditions, his notions, his weaknesses and failings, and teach him in some way, by college extension work or in every other way, to live a better life in the open country. I do not see why we can not take up the subject of showing him even how to enjoy the conveniences that are now supposed to be enjoyed only in the village and in the city. We have many ingenious contrivances by which we can help the farmer by models and plans and other influences so that he can surround himself and his family with modern conveniences. We can help him in planning the location of his buildings, in providing drainage, sanitation, and toilet facilities, and by means of power, either wind power or by the use of the gasoline machine, to enjoy practically every convenience on the farm that is now enjoyed in the village or city, so that the money that is made on the farm can be used to beautify the farm and make farm life more agreeable. I think when that can be done, that is, when we can satisfy a large percentage of our population that in the country is a good place to live, we can help to improve rural social conditions; in fact, change this old-time farmer to a new one by improving his view point of life and of the social conditions with which he can surround himself. I think we will have very little difficulty then in inducing our boys and girls to look to the open country as a very suitable place to live, and the country will be better for it.

A. B. Cordley, of Oregon, presented the following paper on the same subject:

At the beginning of the second half century since the establishment of the first American agricultural college we are coming to grasp the full significance of the movement for which they stand—the betterment of all that pertains to rural life. We now realize as never before that the rural problem is a problem of better living, as well as of better farming, and that the function of

these colleges is to give impetus and direction and aid in the solution not only of the last-mentioned part of the problem, but in the certainly no less important first-mentioned part.

I believe the best way in which an agricultural college can fulfill its complete function is to carefully study its undergraduate and graduate work, adapting it to local conditions and broadening and strengthening it wherever and whenever possible, to the end that its graduates may be efficiently trained not only in technical agriculture, but that they may also have an adequate conception of the political and social problems of the open country. If the leaders of the new rural civilization are to be trained anywhere, and it goes without saying that if they are to be safe and efficient they must be trained, this training must be obtained at the agricultural colleges.

This phase of the college function, however, has been ably discussed. The addresses of Presidents Butterfield, Snyder, and Storms, and of Deans Bailey and Davenport, and others, while they may not have exhausted the subject, have certainly exhausted my capacity to add anything of value.

I am convinced, however, that before the agricultural colleges can wield any great amount of influence—either directly or through their graduates—in solving the social-environment problems of the farm we shall have to recognize and act upon the idea that such social, political, religious, educational, trade and transportation, and other problems offer as rich and proper field for investigation as do those which merely influence production. Competent instruction in technical agriculture became available only with the development of the research functions of the experiment stations, and I believe that such financial and other encouragement as may be necessary to develop their research functions and make them coordinate with the department of technical agriculture should and must be extended to the various departments of history, political and social science, commercial and other similar departments of these colleges. Such departments must become active research agencies before they are likely to become the most efficient teaching agencies.

The influence which the agricultural colleges are to have in redirecting the courses of study in our primary and secondary schools has also been adequately presented by Dean Wickson and others. All that seems to be left to me is to go back to the farm.

It was stated here yesterday, I think by President Bryan, that our knowledge of production far exceeds our knowledge of how to dispose of our products or how best to use that which has been received in exchange for them. The statement is no doubt true, but it does not necessarily follow that the masses of the people who live upon the farm have absorbed appreciably more of one class of information than of the other. While the agricultural colleges have been investigating and teaching better methods of farming, the grange, the farmer's club, rural free delivery, the telephone, and the trolley car have been improving the political and social condition of the farmer.

I fear that no one can travel from the Pacific to the Atlantic coast, as I did last summer, and give attention to the agricultural conditions as he finds them without arriving at the conclusion that while the researches of the stations and the teachings of the colleges have modified the practices of individuals and even of restricted communities, they have not greatly changed those of the farming masses.

If the prices for the necessities of life, in the face of a rapidly increasing population, are to remain such that the American standard of living can be maintained, it is absolutely essential that a system or systems of farming be generally adopted which will not only yield a profit to the farmer but which will also maintain or increase the fertility of the soil. That this can be done is shown by the constantly increasing yields of European farms; that it is not done here is equally well shown by the constantly diminishing average yield of our own acres.

Nevertheless, it can not be expected that better methods will prevail until it can be demonstrated that they are profitable to the individual who adopts them. The farmer can scarcely afford to be a philanthropist. Therefore, any reasonable expenditures by the State or National Government which will tend to hasten the adoption of such methods should be considered as a wise, even a necessary, investment.

The agricultural experiment stations and the Department of Agriculture have accumulated a vast store of facts regarding agricultural science and practice. Through the medium of bulletins, the agricultural press, farmers' institutes, winter short courses, demonstration trains, movable schools of agriculture,

correspondence courses, cooperative demonstrations, experimenters' leagues, etc., effort is being made to bring these facts to the knowledge of the farmer. And of course much has been done toward laying the foundation for a higher standard of farming. It seems, however, to be unquestioned that what is needed most at the present time is to devise still better methods of bringing the knowledge which has already been obtained to the attention of the farmer, and in bringing about on his part desirable modifications in his farm practice. I believe every agricultural college should maintain a well-organized extension department which should aid the farmer and the farmer's wife by any or all of the above methods, as circumstances may permit. But I also believe that we should recognize the fact that these methods all unite in having three serious faults: (1) The teaching is sporadic and the series of facts which are presented are more or less isolated; (2) they reach, principally, the reading, thinking farmers—the class that least needs aid; and (3) they do not demonstrate the practicability of the methods taught. What is further needed, it seems to me, is some method of bringing together the facts of agricultural science, welding them together into a rational system or systems of farm practice and actually demonstrating their practicability and adaptability to local conditions. All of this can be done, I believe, by a system of well-conducted demonstration farms.

If such farms are to fulfill their mission they must be purely demonstration farms and not for experimentation, and they must be more than self-supporting. They should even be more profitable than the systems or lack of system generally in vogue in their respective localities, while at the same time the question of profit must be secondary to that of increasing the fertility of the soil. If the system adopted on any such farm is not profitable, the demonstration is valueless to the farmers; if it fails to increase the soil fertility, it is valueless to the State. Doing both, it becomes of great value both to the farmer and to the State.

Officers of the Section.

E. A. Bryan, on behalf of the committee on nominations, presented a report recommending the election of the following officers: President, S. Avery, of Nebraska; secretary, W. D. Gibbs, of New Hampshire; members of the executive committee, W. O. Thompson, of Ohio, J. L. Snyder, of Michigan, and W. E. Stone, of Indiana.

On motion, duly seconded, the secretary was instructed to cast the ballot of the section for the candidates named, which was done, and the respective candidates were declared elected.

Work of the Country Life Commission.

J. A. MacLean, of Idaho, offered a resolution on this subject, which was referred to the general session of the association with approval of the section, and adopted, as already given on page 44.

The section thereupon adjourned sine die.

SECTION ON EXPERIMENT STATION WORK.

Afternoon Session, Wednesday, August 18, 1909.

The meeting was called to order at 2 p. m. by P. H. Rolfs, of Florida, chairman.

Relation of the Director to the Members of the Station Staff.

E. Davenport, of Illinois, read the following paper:

The relations that shall exist between the director and the members of the staff will depend upon the particular theory of administration adopted for station purposes.

Now, there are three well-defined and distinctly different methods of organizing a body of men to do an effective piece of work. The one that is likely to be employed will depend upon the nature of the work to be undertaken, the numbers and character of the men involved, and the temperament of individuals—indeed, every case of organization involves the whole philosophy of administration. It will facilitate discussion if each of these three theories of organization be briefly outlined.

(1) In the first the director is conceived not only as the highest officer, but as the source of all authority for the station worker, subject only to the governing board.

This is the form of organization best adapted for military purposes, where all results are mass effects and where individual initiative is not necessary or, indeed, altogether desirable. Applied to business or to education it assures what is known as a "strong administration." Such an administration commands peace and prompt service, at least while the authority lasts, but in my judgment it is not the form of organization that is productive of best results in the field of either instruction or of research. Its fatal defect lies in its assumption that all authority is delegated from the administrative head, a defect that not only frees the individual from responsibility, but, what is worse, kills that personal initiative which is the heart and soul of all good work, either instructional or investigational.

In a modified form, with its corners rubbed off, it does well as a form of department organization where most of the employees are of the grade of assistant. In the same denatured form it may do, too, for a small station in which the director is the chief investigator and all others are virtually his assistants, though this undertaking is likely to involve dangerous confusion as between administration and research, a condition likely to make trouble as the station grows and begins to break up into subunits.

Another defect in this system is that the activities of the organization are limited to the capacity of a single individual, and still another is that the best scientists object to subordinating their work to the exigencies of administration. They feel that the administration of a research body is not subject to the onerous limitations of the military, in which all work is team work, and in which results depend upon instant and coordinated action in the pursuit of a definite plan involving previously arranged details.

(2) A second system of organization is the exact opposite of the former. It is distinctly democratic in that it regards the body as composed of peers, and the director as nothing more nor less than a presiding officer, but with no authority whatever over the deliberations of the staff or even their enforcement. This is the form of organization recommended in some quarters for the American university, a form of administration best adapted, I think, to a family of kittens or a nest of bull pups.

Such a proposition virtually proposes to do away with administration altogether. Its defect is that there is no way of regulating affairs, of coordinating

work, of expediting business, or of knowing who is faithfully attending to business and who is not. This defect unfits it for all kinds of public service, because the only way in which a body of men can be held accountable for results is by a system in which one is responsible for many, a responsibility that lays upon him the duty to report, and which in turn must give him the right to require an official accounting. That such a system of organization and administration should be seriously proposed for American universities is almost beyond belief, except that all things are possible.

(3) The third form of organization aims to secure the business facility of the first, and, upon occasion, its administrative strength as well; but it also aims to preserve the comfort and secure the personal initiative of the staff worker by refraining from parading the administrative trumpet and banners. It aims to secure in advance, by frequent and free discussion and by conference, the best judgment of which the staff is capable, and then to see to it that plans are carried out, assuming that every individual is loyal, and understanding that the best scientific service, like the highest loyalty, can never be commanded.

It is a cardinal principle in this method of organization that administration exists for the sake of and to facilitate work, and that work is never to be the servant of administration; that the two are to be kept distinct; that the worker derives his authority not indirectly by delegation from his administrative superior, but directly and arising from and out of the nature of the service he undertakes to render. With this form of organization, administration never exerts its superiority except in emergency, when it does not hesitate to perform any act necessary to the preservation of integrity or the correlation of work. In its day-by-day operations there is little evidence of organization, and none of authority, and it may easily be taken by the casual observer for entire absence of system; indeed, it is more in making plans than in their execution that the organization is used, the theory being that execution is an individual matter, while planning is or ought to be the result of the most carefully organized consideration. It is only occasionally and upon emergency that such an organization is obliged to exert authority to secure results or to employ its power to exact service.

This is the form of organization in which the writer believes and which he tries to maintain. I am perfectly aware that it may appear to the onlooker as a free-for-all race without much organization. All parties, however, are advised not to fool with that kind of a machine, even in its most innocent moments, for if properly put together and reasonably well adjusted and oiled it is ready to go off at any time, and it is the more dangerous because every member of the organization knows the combination and how to work it.

Of course I am writing out of my own experience. It is the best I can do. We try to separate the office and the man. This gives rise to two important distinctions. The first is that the same man may hold two or more offices, a fact that sometimes makes A superior to B and at others reverses the conditions, or even compels a man upon occasion to act as his own subordinate. The other fact is that the same office may be held and its duties discharged by more than one man. For example, in my absence another takes the office and performs the functions of director, in his absence another, and so on indefinitely in regular order. I never leave my office in the hands of a clerk, for I would not permit the head of a department or any other member of a staff to take rulings or decisions from other than an administrative officer. Every day certain matters must be decided and put at rest once for all. It really matters little who decides them, and often but little as to how they are decided. The important points are that they be decided by some one who is a peer of any other one on the ground. The other important consideration is that once decided the matter must be ended, and I would no more review or reverse the decision of a temporary occupant of the office than I would offer him personal insult, and whether I would have made the same decision or not I should accept his ruling while in my office as final. This much of the military method I most heartily indorse and believe in.

In the practical operation of this plan nearly everybody in the station has had experience in discharging the duties of his superior, for the same method is extended into the departments, and every interest is always at home and ready for business. At one time last year twelve of the principal officers of our station were away at one time, but affairs proceeded precisely as if every man were filling the office to which he was elected.

The best proof of a system is its working, and I am glad to say that during the dozen years of the operation of this policy there has been no single case of

reversal of the acts of another, and only one case of neglect to scrupulously respect and observe the rulings and acts of the temporary head—in this case, not the director, but the head of a department. That member of the staff got his lesson at once and will, I think, never need it repeated.

I can now very quickly give my conception of the relation between the director and the members of the staff. First of all, the director is an officer, not an individual. As a policeman is an officer only when he wears his star, and as a member of the board of trustees is an officer of the station only when the board is sitting in a body, so the director is director only when acting in that particular official capacity. At other times he is the station worker like other members of the staff, and the less he parades his uniform the better, lest he appear to profit by administrative advantage.

All our difficulties arise by reason of confusion as to rights and duties, and most of us are too prone to forget that we as individuals serve in a variety of capacities. We are too conscious of the most influential office in our possession and carry ourselves always as if in the discharge of the functions of that particular highest office.

In its strictest sense the director as an officer has the right to expect the fullest devotion and the freest service to the station from every member of the staff, and if not cheerfully accorded his obligations of higher authority give him the right and make it his duty to exact it and to take any measures necessary to secure results.

As an individual he is, or ought to be, all things considered, a peer of his fellows, nothing more, and hopefully nothing less. If he is a good director he will have associates that are his superior in the lines for which they were employed, and his duty is to make it possible for them to render their service in comfort and without pestiferous interference from anybody, just as he has the right to expect that all the power and personal influence of every member of the staff will always, and at all times, be exerted to the preservation of the integrity of the station and the protection of the work and the rights of every member of its staff.

I have tried to draw two fundamental distinctions, one between the office and the man that holds it, the other between administration and work. The station exists for the work it can accomplish and for no other reason; hence, under all ordinary conditions, administration is subordinate and not superior to work, and it is only when the integrity of the organization is at stake or when some one proves untrue to his post that administration becomes superior—this is upon the principle that to preserve existence is the first law of all things. All good work is the result of intense individual effort, and it should therefore be the first purpose of the director, like all other administrative officers, to bring the individual and work into the closest possible relations. When we do this, and when we remember the distinction between the office and the man, then is the ground prepared for the closest and the sweetest of human relations between the director and the members of his staff, relations that soon permeate the body and ultimately come to characterize the body as a whole and that go far to temper adversity and disappointment and to blunt the sting of occasional administrative exigency. That these relations may be close and sympathetic, I do not believe that the worker should be freed from all administrative responsibility. He is the better if he wears the harness a little and learns to take the rubbing. Neither do I believe that the director's time should all be concerned with executive work. He is the better administrator and the more sympathetic adviser if he himself also from day to day functions somewhat as a station worker. When he does this let him lay off the harness for the moment that the galls may dry off and heal over. This is my best counsel to the young director, except that the administrative harness should always be lightly worn, for it is only occasionally that the director needs to rise in his stirrups and flay his enemies, and when this time comes the best of all help is the loyal support of his staff who believe in him as a human being because his treatment has been broad and sympathetic, not that of a powerful administrative officer exacting the utmost of his advantage.

This paper would be incomplete without reference to a common and very special kind of relationship between the director and members of the staff. I refer to the young, inexperienced, and growing man who has promise of a shining future—the coming man who has not yet arrived—to distinguish him from the larger mass that will never rise above mediocrity; to distinguish him and help him to develop—this is the highest of all the many functions of a director.

A. D. Selby, of Ohio, presented the following paper on the same subject:

The writer has been interested to study the matter as presented by Director Davenport and cordially supports the views held as to the proper method of station organization.

It is not questioned that possible administrative strength is a necessary and vital consideration in the handling of so great a business enterprise as is found actually existing in the experiment station with which I am most familiar. Any other point of view would almost surely prove hazardous and likely fall short of satisfactory achievement in investigation because of the very great danger that loose methods of administration would in turn react to produce lax methods of investigation. The experiment station to serve its real purpose and to provide for continued agricultural progress may not foster laxity of methods in study nor indefiniteness of aim in its researches. It may further be assumed that we are all essentially agreed upon the ultimate aims of the experiment station work in one's charge and the various administrative necessities imposed. Even with this agreement it may or may not follow that station work is not to be made and not infrequently will be made the servant of administration. While granting the correctness of this cardinal principle that work should never be made such a servant, and that danger exists under such condition, the condition almost certainly arises from the source of support of the average experiment station, and from the extremely diverse character of the work conducted by different members of the station staff as well as from the equally varied exactions imposed by the preparation of the investigator himself. This statement is not with any thought of its being an original or even a late-day observation. The writer has been engaged for fifteen years, consecutively, in essentially a single line of service at the Ohio station, and all of this service has been under the same person as director of the station. While this continuity of service with respect both to director and staff member may not make for breadth of personal experience with different individuals, it offers an excellent opportunity to realize more completely the discoveries demanded of the station investigators and the probable means of their attainment. Such continuity offers fairly acceptable evidence as to the mutually satisfactory nature of the relations existing between the director of the station and the particular staff member. I wish to bear further my personal testimony to the same mutually satisfactory relations. It is well to add, moreover, at this time, that as station botanist very largely engaged in plant disease investigations, the writer has not been pursuing a line of research that, in its subject-matter or its nature, per se, may be sufficiently familiar or within the daily range of practical experience to such an extent as to appeal very powerfully to the average farmer. I take it, further, that in this respect the mysteries of plant life and of the activities of plant protoplasm tend rather to a natural repression of interest in plant pathology as compared with the expression given to interest in the problems of the apparently inanimate soil, which all have learned in rural practice "to turn with their plowshare and tread upon."

Not alone from our individual conceptions of the proper theory or method of station administration and the mutual individualities of the director and staff member will be derived the final determining factors in this matter. Whether or not we may realize it in looking at these relations, the line of investigation will in itself have much to do in shaping the final status of these relations.

The support of most experiment stations is derived from at least two distinct sources, namely, appropriations from the National Government and appropriations from the State. With some stations fees from inspection or control work are to be considered. The source of support is a factor of great weight in determining many of the relations of the investigator.

No staff member of long experience has always had from year to year the same satisfactory experience in departmental support. The causes need not be recounted but the facts are as they have been with each of us. The facts as to relative funds may vary considerably as between stations connected with agricultural colleges and those independent of such connection, as we are in Ohio. The discussion has to do more directly with our own conditions. The separation or essential separation of administration and investigation, as stated by Director Davenport, demands as a corollary that the administration of the station shall at all times be able to place at the disposal of each staff member an amount of funds which shall leave him relatively free to pursue his investigations. In case the station is not able to provide this requisite sum, will the administration expect the staff member to subordinate his inves-

tigations, for which he may have been some years in preparing by preliminary work of various kinds, to the exigencies of station support, or is he to spend time and energy in securing for himself by quasi administrative duties the fund so necessary for his real work? I can see no escape from one or the other of these alternatives. While cases of the kind stated may be called special or unusual ones, the type of case is very common. It is even more than probable that conditions of this type are the most usual basis for strained relations between the director of the station and the members of his staff. From the very nature of the pursuits of the station investigator, the limits of adaptation for this work to state-wide variations in income or interest are relatively narrow—men so engaged get ready but once for a given line of work. A hiatus results if the work then fails. Herein may arise the issues which result in much loss of effort through changes of men from one station to another. While the cases are individual the basal scientific investigations are vital to agricultural progress.

I believe that few men of experience in either station administration or investigation will deny the very obvious risk involved in the interrelations between the views held by the agricultural public as to what is needed at any given time and the possible support obtainable by the director for the station's work. That it is easier to yield to pressure from without than to organize and direct it is also possible. From the character of station organization the vital thing to the staff member is timeliness and continuity of departmental support. Out of its failure from any cause may easily grow strained relations.

Further, it is more than possible that the fidelity of the station director and his staff members to the high ideals of the station's mission in directing agricultural development rather than in simply moving with it, may decide, in the course of time, whether these institutions are to exist as virile centers of investigation or fall much below that ideal. Any effort at the development of the results of the drifting policies seems scarcely in place. I presume it is even probable that like temperaments segregate at a given institution. The feature is mentioned to bring out as clearly and as concisely as may be, some matters the staff member must receive at the hands of his director or fail in his own lines.

The first is adequate financial and moral support.

Another consists of an appreciation and sustained interest in the work the officer is planning or pursuing; while yet others proceed from the more individual circumstances which may exist.

The reactionary influence of any failure of the director to support and show reasonable interest in the work of the staff member will soon be apparent in most departments of any station. The director's interest if shown in certain directions will inevitably result in corresponding development in such lines. Since so much will proceed from the mental attitude of the director, his training will profoundly influence his relations to the members of his staff.

There may be greater disadvantage than advantage in having an investigator within a restricted field to serve also as director; as a corollary, so to speak, the director must be looked to for certain standards of station service. He must have some just conception of the nature and of the difficulties surrounding each of the many lines of station work or some of this work will surely languish.

Without emphasizing unduly these interrelations of director and staff member, which I have been at some pains to present, I wish to consider some of these things which have to do with the standards of research. We do not need to parade the excellencies of scientific research to realize these ideals of effectiveness. The exactions of investigations in science are fairly well appreciated. Few lines of station work consist of purely scientific investigations. Experiment station work is typically the study of practice in applying science to agricultural production, including animal husbandry. Applied science must possess that dual nature which it at all times shows. It consists of its rigorously proved facts and the more or less tentative results of their application to living organisms.

Accordingly as a man's training has been of the exact type or has been supplied by data of more practical character, his standards and his ideals will be molded. Have not American experiment stations suffered from inadequate ideals? If we answer "no" to this question we are then forced to ask, Has pressure from the agricultural world been the source of direction?

Any analysis will lead to the recognition of many determining forces. Yet the writer believes that the chief ones are covered by the statement previously made of the relations existing between the sources of station funds and the

demands for certain work. There is some analogy between the experiment station situation and the flow of water in an open channel. "The stream can not rise higher than its source" we have long been advised. Has the station been able to rise higher than its source of motive power? There is at least inadequate evidence that it has done so.

I may illustrate even better the effects of these groups of influences by following the course of development taken by plant pathology in America.

In the beginning, we had available the laboratory literature of our diligent German friends in which the fungi of plant diseases were given satisfactory treatment. In these the mycological side of the science had been well developed. At the same time the outdoor or host aspect of the subject had been inadequately investigated. The matter of therapeutic or treatment measures for diseases had been imperfectly considered except as Millardet in France had brought out the basic facts concerning Bordeaux mixture and was followed by Jensen in his hot-water treatments for grain smuts.

The course of plant pathology has continued along its previous lines in Europe. While there has been discovery and improvement in methods, the literature of the subject from the European standpoint continues to be purely or almost purely mycological.

In America we have been even more diligently engaged in pathological work than the Europeans and we have been content to use the European texts for instruction since they are all that have been available. Yet despite these sources of instruction the work of plant pathology with us has been very largely from the standpoint of the host and crop. The development of methods of control and the success of the methods employed in the treatment and prevention of plant diseases in America have gone far beyond anything that has been produced elsewhere. As was remarked last winter by a well-known Eastern plant pathologist, "America is so far ahead of Europe, including the Germans who may be said to have originated the science of plant pathology, in the application of treatment methods that the subject has become almost a new line of work." In view of these facts we may properly ask what influences have brought about this result and along with them what influences have resulted in the rather indifferent laboratory development of the study of parasites in America. It seems to me that the influences have come from the fact that our institutions, including experiment stations, have been able to obtain support for the work in disease prevention, and on the other hand, it has been difficult to get adequate funds for the narrower and more strictly scientific study of the laboratory. We see the results of this necessity by one-sided development upon every hand and we have reached the point where without the development of the laboratory side of the subject progress will be restricted. I believe the same state of facts applies in a number of lines of experiment station work. I am firmly convinced that the staff members must in the future receive a more liberal support in this line from the administrative officers of the station or the progress will be very slow. Does the station director feel keenly enough, as a rule, this necessity? Whether or not he does it is very plain to the writer that the members of the staff in charge of such lines of investigation have felt it for several years past. While it is granted that the Adams fund is designed to attain this end it is insufficient in large stations. I wish to make appeal for the hearty support of station directors along these lines.

H. J. Wheeler, of Rhode Island. At the Rhode Island station several years ago the station council, consisting of the heads of the departments, the first assistants, and the director of the station, apportioned the funds to the different departments. That plan does not appeal to me as at all satisfactory, and I do not think it tends to promote the best of relations between the heads of the departments or between the director and heads of departments. So far as my experience goes the best system of administration (and in this I expect to be disputed) is to give the director entire charge of the funds. If he is a wise director, I think he will plan to undertake so few lines of work that he can surely furnish to every head of a department everything that he can reasonably expect as necessary to make the department a success. Under such a plan there is no complaint, for all get what they want, and at the end of the year there is usually a little money that can be distributed in the

different departments for books or special apparatus. I have been more than pleased with the system, and I believe that every man that has worked under it has been pleased. The system, in a way, is equivalent to an apportionment, since each head of a department learns in advance from the director that his plans for the year can be carried through.

H. L. RUSSELL. Under the conditions in Wisconsin I believe that it is better to have the funds largely under the control of one individual. I think, however, it is very necessary that there be a factor of safety in the way of a considerable amount to meet emergencies. With us it is customary each year to prepare an annual budget. Each department is called upon to present its needs both with reference to salaries and maintenance, and these are then gone over after they are assembled to find out whether or not they are within the limits of possibilities. Then the budget is made up by the director on the basis of these departmental estimates taken in the light of the previous years' experience, also considering, of course, the possibility of new lines of work being developed, while a factor of about 5 per cent is maintained for a reserve. Each department, if it finds that it is not sufficiently provided with funds, may come to the director during the course of the year with a statement as to needs, and is supplied from this reserve. In that way we are always on the safe side, and still the funds are divided not in the manner referred to, by parceling out to the different departments a definite amount, but by a sort of combination of departmental and director's estimates. In that way our funds, I think, are husbanded probably more satisfactorily than they would be if controlled by a committee.

J. L. HILLS. The method that Dean Russell has outlined resembles one which has been used at Vermont. At the end of the fiscal year the director, after consultation with departmental heads, has made out the budget upon the basis of the previous years' experience, leaving a 10 per cent leeway for contingencies. If, then, toward the end of the year one department of the station is tending toward an overexpenditure and another toward an underexpenditure, and one can help the other out, it is done; and the 10 per cent contingent fund is likewise drawn upon. The method on the whole works well.

H. J. WHEELER. We have accumulated at our station several thousand dollars of surplus which can be drawn upon at any time, so that if a certain department needs $500 to get special apparatus in a certain line we can get it, or if a sudden need of assistance arises in a department it can be met.

E. DAVENPORT. It seems to me we can avoid a great many pitfalls and misunderstandings by a thorough understanding before any new department is opened. We have at our station what we call a conference of the different departments, which meets once a week, and no department undertakes any new movement, new experiment, new line of departure of any sort, without it is fully talked over in that conference. Frequently in planning experiments a good many departments possibly may be involved in the same experiment, and that in general is what I had reference to. It is not well for a director and one member of the station staff to plan an experiment by themselves alone without the other members of the staff knowing about it. I think we waste a good deal of time in our experiments by not talking matters over in advance. It seems to me there is great danger in launching undertakings without a common understanding all around of what the undertaking is to be and what the purpose is.

A DELEGATE. How far do you think the director should keep posted with the progress?

E. DAVENPORT. I think it would be better for him not to know much about the details. It is well enough for him to know that things are progressing

well, but the director who calls at the station each morning and assigns the work for the day is not a good director. It seems to me it is not well for the director to give too much attention to details, but at the beginning to give a good deal of time, a good deal of care, with the station worker, to defining experiments, their plan and purpose, and to discussing back and forth methods of procedure. Then he can very well let the work alone until results are due. In other words, we must assume that the station worker is skillful in his line. We must assume some things and trust each other a little.

It seems to me where there is an understanding of the nature of the experiment, the purpose to be achieved, and the funds at the disposal of the station for that purpose, in a general way the course of procedure ought to be talked over thoroughly between the director and the man who does the work and with all others who are interested.

H. J. Wheeler. Do you not think it is a good thing for the director to follow the details and to keep in touch with the work enough to show that he is in sympathy with it at all times?

E. Davenport. If a director were able to be at half a dozen places at once he might do it.

T. F. Hunt, of Pennsylvania. Do you keep a record in the director's office which shows what progress is being made by the different station workers?

E. Davenport. No, sir; we do not. It would not be possible in our station. Each department (we have five) has its own headquarters. The records are kept there and the director's office pays no further attention to the department records.

T. F. Hunt. Suppose the head of a department should die and you wanted, as director, to know the condition of that department, what means of determining the progress of the various pieces of work have you?

E. Davenport. The regulations are that the records must be kept so any man can tell.

In the system followed at the Illinois station the director lets go of the funds just as soon as possible, and he does not have any 10 per cent or 5 per cent reserve. The department understands that when the money which is assigned to it is used no more is to be had. But the assignment of money is the result of conference. When the question of the appropriation for certain lines of work comes up, all heads of departments go into conference on the matter and the funds are apportioned on the basis of an agreement as to the needs of all of the departments. An agreement is reached; every man knows why the other man needs more or can get along with less. That closes the financial question for the year.

R. W. Thatcher, of Washington. What is the relation of the director to a completed project, the publication of a completed project? I have observed two attitudes upon that matter. One is that the results of the completed problems are the property, in a professional sense at least, of the investigator, and that the wording, the formulation of the data, and so on, for publication, are his own and that no one else has any right to edit it. On the other hand I have seen the theory advanced that the director is as an administrative officer responsible to the State and to his constituency for getting the information to them in the best possible manner, and that he has a moral obligation to see that the results of the completed project are published in what would be the best form in which they may reach his constituency. In other words, has the director the right to edit the results of his investigator's work?

E. Davenport. That strikes at one of the chief questions in administration. I think the director has the right to edit if necessary. If I felt it was my duty

to hold up a bulletin written by a member of the staff, it would be exceedingly hard, but I would do it. It is a rare case, however, in which a director is justified in either suppressing a report of a piece of work or turning it over to somebody else to have it worked over. I have done that thing, however, and I think, in the case of an emergency, it is the province of the director to see that matter is put out in proper shape; but in all ordinary cases the work shall go out as prepared.

J. Craig, of New York. There seems to be two systems of organization of station and college departments, the one making for a large number of small departments with heads answerable directly to the head of the college or station, and the other making for a small number of large departments under one head, who deals with the executive, and I am wondering whether there is any unity of opinion upon these methods of organization. With regard to the department appropriations, the method outlined by Dean Russell is the one which we have found satisfactory at Cornell. In support of it I might say that it gives the head of the department an excellent opportunity of keeping in close touch with the progress of affairs.

E. Davenport. In Illinois we are drifting to large departments. I do not think there was any special determination to do it in the first place. The university, however, seems to believe in the plan of fewer and larger departments. Whether that will prove the wisest in the end I do not know. It is most comfortable for the director, and it looks like the wisest way to maintain a large number of people in a complex organization.

A. C. True. I think this is one of the undetermined questions, as Dean Davenport believes. I would say that at present the general idea is to have relatively few departments. I have found that quite different situations present themselves in different stations. In some stations there is no doubt that the director undertakes to make himself responsible for the station's work in an exemplary way, but I am inclined to think there are more cases where the director does not follow the work of his station closely enough. Some directors do not seem to appreciate the importance of such relations with their staffs that the latter will look upon the director as really the determining factor in the organization of the work of the station. That is brought out in connection with the Adams fund work. There have been a good many instances in which the plans for the Adams fund work were transmitted to the Office of Experiment Stations just as they were transmitted to the station director, and there was no evidence that the director had carefully considered the plans or passed upon their merits in a general way in the first place.

The director of a station is not to be considered an expert in all the different lines in which the station is operating, but that is equally true of the Office of Experiment Stations, and to submit to the Office plans of work which have not been thoroughly digested with reference to their general character and fitness is, it seems to me, simply transferring the proper business of the director over to us and asking us to do things which are not our proper business. I speak of that simply by way of illustration of general principles. It seems to me that the director of a station should follow the business of the station closely; should exercise his authority as director of the station and see that the plans of work are properly considered, properly made, and properly carried out. I think all that can be brought about much in the way in which Dean Davenport has set forth, and yet retain the confidence, support, and respect of the station staff.

H. L. Russell. One of the most fruitful things we have had in our experience is the formulation of projects in a well-defined way. Our method is that

when a department wants to take up a long line of work it submits a succinct statement of the experiment, its subject, stating briefly how the experiment is to be performed, the name of the experimenter, whether the work is to be done independently, in coordination with some other departments of the station, or in cooperation with other organizations in the State, and also an estimate of the cost. This makes a definite project which comes to the executive department and is there passed upon. Now, that gives an opportunity for the director and for the department concerned to go over thoroughly and fully the details of the experiment. I think that if some such method were universally followed it would result in a large saving of money. In my experience I have seen instances where material has actually been bought, animals have been purchased for experimental purposes, and when the experiment was started it was found to be absolutely impracticable. If the thing had been worked out in advance this expenditure would not have been incurred. Therefore I believe that the working out of a well-defined project submitted in writing is of great importance. The project is generally accepted after a conference with the director, and an assignment of funds is made, and then at irregular intervals, at least once or twice a year, the department ought to make a report upon the progress of the work, so that there is in the executive office a record substantially of the whole transaction of each experiment. The experiment may last for three or four or five years, but there is a continuing record, and when the project is completed it is so indexed in the executive office and reference made to any publication that may have been made. I believe that the introduction of some such a system as this is a valuable thing from the executive point of view, because as our institutions increase in size it becomes more and more difficult for the director to have personal knowledge of work being carried on.

In the early days of experiment station work when there were few men, it was possible for the director to carry all these ideas in his mind.

L. G. Carpenter, of Colorado. We have found it desirable to take up some such a system as Dean Russell has indicated, and it is working out somewhat along the same line. Definite projects are reported in advance and then records kept.

In addition to attempting to get a perfectly definite statement of the objects of the investigation or project in advance, a definite statement of the method that is proposed to be adopted is desired. Of course these are all subject to changes that may become necessary. In addition to that we attempt to get a definite estimate both of time and money. We have found each of these equally important. The estimate sheet goes into detail as to traveling expenses, as to apparatus, as to printing, and as to the various items that go to make up the estimate. An estimate of time is important because everyone connected with this kind of work knows that many people like to distribute their time over half a dozen projects or investigations without realizing that they do not have ample time to give some particular project the proper investigation.

It seems to me that the relation of the director to the men is one that must vary much. So far as desirable the connection should be almost as loose as is possible for associate work. With good sense and good management almost any system will work under certain conditions, and if not it may be so modified that it will work.

We have had some cases in which when men left the station we found the records were in such shape that nothing could be done with them, and the work they had done was absolutely lost. This has almost forced the keeping of a closer supervision of records. Indeed, I think it is almost necessary for workers

individually and collectively to realize that there must be a sufficient record and continuity in station work even though there may be a change in the men.

In reply to a question H. L. Russell stated that in Wisconsin there was an annual budget, but in the conduct of the university business requisitions were made for six months.

H. J. WHEELER. There is an arrangement in the Rhode Island station by which the head of a department may buy small supplies, five or ten dollars' worth, pay the cash and take a receipt, and be promptly reimbursed. Thus anyone is free at any moment to get any little thing that is needed.

RESEARCH JOURNAL FOR EXPERIMENT STATIONS.

E. DAVENPORT. There has been a good deal of talk for a number of years about the need of a new publication for station results, especially those which emanate from the Adams work. The matter has been before the committee on station organization and policy, and the committee has drawn up a rough outline of a plan (see p. 48).

C. D. WOODS. It may be interesting to know that this matter has been under study by the committee on station organization and policy for now about eighteen months and was taken up last autumn by correspondence with each experiment station for the purpose of getting the views of the stations on various matters relating to the journal or medium of publication. The consensus of opinion of at least two-thirds of the experiment stations is that a medium is necessary, and that if a medium is to be obtained at all it must come by government support and not by contributions of the stations. There is general agreement that there ought to be some such journal or some means of publishing the matter which otherwise would be too technical for our general station publications.

A. C. TRUE. It will be understood that in speaking upon this subject I do not represent the Secretary of Agriculture. What I have done has been merely in the way of aiding the committee to formulate a definite plan for your consideration, which is to be presented to the Secretary of Agriculture with reference to his approval. As far as the general proposition is concerned, however, I may properly say that I am very deeply impressed with the need of a common medium for the publication of the scientific work of the stations, and that is aside entirely from the question of the support or conduct of such a medium, whether it is to be done by private subscription or by contributions from the stations or by a congressional appropriation. At present we have this condition of things: Our station publications, as a whole, are of such a miscellaneous character that they fully satisfy nobody. Most of them are written with the primary purpose of reaching a large and popular audience, and whether they embody scientific work or not, the effort is made to present the material in such a way as will be acceptable and instructive to the layman, especially the farmer. At the same time the scientific workers naturally want to present the matter so that it will be acceptable to scientific men. Thus they have in mind as they write these publications the necessities of a scientific presentation of the subject. The result is that they do neither one thing nor the other, and the material is not put in scientific form or in good popular form.

One result is that most of the station bulletins, even though they claim to contain original work, are so written that it is very difficult to tell what original work was actually done. Some of our stations which present their matter in the most attractive form are subject to that criticism. Scientific men in general have not as high an estimate of the work of our stations as the work warrants. More than that, the scientific world, taking in Europe as well as America, is not able to obtain in any complete way the publications of the

stations under present conditions. Scientific men, therefore, have to content themselves very largely with the presentation of this work through the Experiment Station Record, and that is entirely inadequate and must always be so. If we could have some common medium for the publication of scientific work of the stations so it could be put out in good form and published apart from the mass of popular material and extension work that the stations have to do under present conditions it would, in my judgment, be a great gain in every way. It would raise the scientific reputation and standing of our stations. It would make possible the employment of a higher grade of scientific men in many cases in our stations, since they would find the work much more attractive. On the other hand, the farmer would be better pleased, because if this scientific work was once separated out and the ordinary bulletins of the stations were prepared primarily in simple and untechnical language, undoubtedly the matter would be much better presented for the farmer's use. There is no doubt that a great deal of the influence that the stations might have is lost at present, because their work is put out in such form that the farmer is discouraged in the attempt to find out what the stations actually do which is of real practical significance.

For these reasons briefly stated I think it is very important that this matter should be carefully considered by this association, and I am certain there should be a decided effort to get some common medium for the publication of the scientific work of our stations.

If this matter is favorably considered by the association and by the Secretary of Agriculture in any such form as has been here presented, it will, of course, be necessary to go to Congress for the money with which to print this journal. That will not involve asking for a large appropriation as appropriations go, but I think it will require the united effort of the colleges and stations to secure early favorable consideration of the matter by Congress. That grows out of the fact that at present there is a feeling in Congress that the Government is doing altogether too much printing, and in some respects I agree with that position. It will have to be made clear through the committees and individual members who are to vote upon this matter that this is a very special case; that there is a real need, and that it is a matter of great importance to our agricultural institutions that we should have a proper medium for the presentation of their scientific work.

I am inclined to think that an initial appropriation of $25,000 or $30,000 would enable us to start this work and put the scheme in operation. I should expect the amount to grow steadily, but it will take some little time to get this matter well organized and going. The first few years I should expect a rather moderate amount of printing would be required. We would have, of course, to have an editorial office, with a competent scientific man at the head of it as the managing editor, and such clerical assistance and others as he might need.

J. Withycombe, of Oregon. There is great need of a scientific journal that represents the results of all this large expenditure of government money. I believe that we can compare as a nation with any country if this work is compiled and properly published.

T. F. Hunt. I wish to ask whether the word "journal" is a fortunate name or term. I think the word "journal" would not be a good term.

C. D. Woods explained that the term "journal" was only tentatively proposed.

A. C. True. I do not think that any great stress should be laid on the term "journal." On the whole, I believe it would be better to have a series of publications so united that it would be possible to issue them with some regularity, keep track of them in a regular way, and have suitable indexes prepared at

reasonable intervals. Perhaps Dean Hunt has in mind the question as to how the individual station can get the particular articles in which it is interested. I do not think that there is any more difficulty about that if the matter is put in the form of a journal than if it is put in the form of monographs. A journal can be prepared so that each station can have a considerable number of copies of individual papers. These separates can be so printed that they can be put out in the form of bulletins by the stations if desired. Personally I do not see any great objection to a journal of agricultural research. This would come to be recognized in the scientific world, and it would be easy to find volume 10 or 20 of this journal, whereas it might not be so easy to find monograph 350.

The proposal of the committee with reference to a research journal for the experiment stations was approved.

Officers of the Section.

On motion of J. L. Hills, of Vermont, the chair appointed as a committee to nominate officers for the ensuing year, C. E. Thorne, of Ohio; H. L. Russell, of Wisconsin; and L. G. Carpenter, of Colorado. (See p. 121.)

On motion, the section adjourned until 2 o'clock p. m. Thursday, August 19.

Afternoon Session, Thursday, August 19, 1909.

The chairman called the meeting to order at 2 o'clock p. m.

General Problems of Irrigation and Methods of Attacking Them Experimentally.

J. A. Widtsoe, of Utah, read the following paper:

Irrigation studies fall, naturally, into three great divisions: (1) The conservation of the natural precipitation, (2) the conveyance of water to the farms, and (3) the use of water on the farms.

The first division, which deals with the conservation of the natural precipitation, lies largely outside of the field of the experiment stations. Under existing conditions, the stations should not undertake surveys for suitable reservoir sites or the construction of great dams and canals for the storage of the waters that flow from the highlands to the valleys. This work is being well done by the Reclamation Service and many of the western state governments.

One method of conserving the natural precipitation is, however, properly a subject for station research, namely, the storage in the soil, for agricultural purposes, of the rain and snow that falls upon the farms. It is a well-established fact that the natural precipitation over the larger portion of the arid region is not sufficiently great to pass through the deep soils to the distant standing water table. If the natural precipitation could be made to enter these deep soils, it would mean much for western agriculture. In fact, the practice of dry farming rests chiefly upon the conservation of the natural precipitation in the soil. The Utah station has found that it is possible to store in the upper 8 or 10 feet of soil, most of the winter precipitation, that is, the precipitation between harvest and spring seed time. In one season as high as 96 per cent of the total winter precipitation was found in the soil in the spring. It is generally agreed that the amount of irrigation water to be applied to fields should be varied with the amount of water found in the soil in late spring or early summer. In districts otherwise similar where the winter precipitation is only 5 inches, much more water must be used during the irrigation season than where the winter precipitation is 15 or more inches. The amount of the natural precipitation on agricultural lands and the proportion of it that may be stored in the soil will in the end be vitally important in determining the duty of irrigation water. It may be said, safely, that if the winter precipitation over the farms of Utah be properly conserved the irrigated area of the State may be increased one-third without the building of another reservoir or canal. To some degree this principle holds no doubt for many of the other Western States.

The western stations should begin early the study of their respective States with respect to the relations of rainfall, depth of soil, water holding capacities of various soils under field conditions, and the numerous other questions that group themselves naturally about the problem of storing the natural precipitation in the soil. Among other things this will require soil surveys from a new point of view, namely, that of water holding capacity. In passing it may be suggested that in this work the surveys of the Bureau of Soils of this Department may find practical application. Then, after these fundamental surveys have been made more or less extensively, the next great question will concern itself with the best methods of soil treatment for enabling the rains and snows to enter quickly and deeply into the soil, away from the dissipating influence of sunshine and winds. The Utah station has come to advocate for this purpose the general practice of fall plowing and the leaving of the land in the rough condition throughout the fall and winter months, but in other States a different practice may be more effective. After the precipitation has entered the soil, the problem is to keep it there until needed by plants. The stations must, therefore, develop methods whereby water, stored in the soil through the winter months, may be kept there during the warmer months of spring and summer. This done, it must be determined by what means the spring and summer rains may be stored in soils to be of the greatest use in the production of crops. This division of the irrigation problem, which deals with the conservation of the natural precipitation, omitting entirely the construction of reservoirs and dams, offers a field, fascinating and profitable, that may and should occupy students of irrigation and dry farming for some years to come. Ultimately, the work, because of its fundamental nature, must be done. Why not begin it now?

The second division of the general irrigation problem deals with the conveyance of water to the farms. It is likewise of great importance, but in its relation to experiment-station work it partakes more of the engineer's work than does either of the other divisions. The leaky lateral is the cause of great loss of water from the high-lying lands. The water thus lost causes the rise of alkali in the lower valleys. The irrigation investigations of the Office of Experiment Stations have shown repeatedly and emphatically the necessity of devising means for preventing the leaks in canals, their laterals, and farm ditches. One Utah ditch, less than a mile in length, loses by seepage 40 per cent of the water flowing through it. The immense western deposits of various kinds of clay and other cementing materials should make it possible to devise some cheap and effective means for lining the ditches that lead from the canals to the farms. A little systematic experimental work would undoubtedly make it easier for the farmer to maintain his ditches in the most effective condition. Under this division of the general problem must be placed also the work of perfecting and simplifying the methods of measuring the water in irrigation systems. The head gates of the laterals, though gradually improving, are still of the most primitive kind. The water masters, with present means, can make only approximate divisions of the water in the canals under their control. The farmer himself, who should be most vitally interested, seldom has any conception of the actual amount of water that he should receive and the number of acres of land that it should reasonably be made to cover. With him it is very largely a matter of so many "streams," to be used as best he can on his farm, whether it be 40 or 400 acres in area. The evils of over-irrigation are due, in a large part, to the fact that the farmer does not know clearly the actual quantity of water he is receiving and the area of land each unit of water should irrigate. During the last ten or fifteen years few new contrivances for measuring and dividing water have been proposed. It is beyond belief that the best possible devices have been invented. The dearth of new inventions is probably more likely due to the fact that human intelligence has not been directed seriously toward this problem. It is one of the most important for the stations to solve, for the correct use of water can not be expected until rational methods of dividing and measuring water have been devised and popularized. Meanwhile the second division of the irrigation problem, dealing with the conveyance of water to the farms, offers a large and promising field for the investigator who has an agricultural engineering training.

The third division of the irrigation problem deals with the use of water on the farms. Though it can hardly be said to be more important, it is more comprehensive than either of the other two, since it must be attacked with reference, first, to the soils of the farms, and, secondly, to the crops grown on them.

The relation of soils to the proper use of irrigation water is a subject sadly in need of systematic study and which, without question, will yield important results. In all soil studies that connect themselves with irrigation it should be borne in mind that in many respects humid and arid soils are fundamentally different. The movement of water in soils under conditions of irrigation needs to be studied exhaustively, largely for the purpose of determining to what extent the mass of data gathered by students of the movement of soil moisture under humid conditions may safely be applied under conditions prevailing in arid districts. The downward, lateral, and upward movements of soil water are influenced by numerous factors, such as the nature of the soil, the quantity of water applied, the moisture already in the soil, the manner of application—whether surface or subirrigation—and the crop growing on the soil. The value of all such factors should, as far as possible, be determined quantitatively for a variety of type soils. Intimately connected with the question of the movement of soil moisture is that of the factors influencing the loss of water from the soil. Investigations are needed that will show definitely the rate of loss of water under various conditions and for different soils, from bare soils and from soils on which crops are growing. The Utah station has shown that the rate of loss of soil water is strongly affected by the nature and depth of the soil, the hardpan, the gravel streaks, the percentage of water in the soil, the meteorological factors—temperature, relative humidity, sunshine, and showers—the time after irrigation, the condition of the top soil, the method of irrigation, and the kind and age of the crop. Only by the accurate determination for a variety of soils of the value of these factors can really reliable suggestions be made to the farmer concerning the proper methods of conserving the moisture applied to the soils in the form of irrigation water or rain and snow.

Stirring the top soil has long since been demonstrated to be an effective method of diminishing the evaporation from soils, yet little is known about the time after irrigation when cultivation is most useful, and the depth to which it should be practiced on different soil types. In fact, it is not absolutely certain that cultivation will check evaporation from every soil, for in the Utah work one kind has been found which invariably loses more water when cultivated than when left sunbaked. Moreover, evaporation from bare soils may be checked in other ways, as, for instance, by the addition or removal of soluble salts. This invites questions pertaining to alkali and drainage. Other means may undoubtedly also be found. It is certain, however, that by reducing the evaporation of water from the soil, the possible irrigated area may be correspondingly increased, and thus the necessary work of such an investigation is fully justified.

Fully one-half or more of the water lost on a cropped irrigated field is evaporated from the plants by the process of transpiration. It seems that plants can not regulate the amount of water that they take from the soil, but, other conditions being the same, the larger the quantity of water presented to the plant roots, the more is used. In view of this condition any soil treatment that regulates transpiration will be tremendously important. Nearest at hand, in this matter, lies the determination of the optimum percentage of water that should be found in the soil after each irrigation, keeping in mind both the rate of transpiration and that of assimilation. This determination to be of real value should be made with reference to a variety of soils. However, in the study of the regulation of transpiration another field of investigation is opened. Investigators in humid climates have shown repeatedly that the amount of water actually transpired by a plant varies with the composition of the soil itself; that is, the number of pounds of water required for the production of 1 pound of dry matter is increased or diminished, according to the available plant food. In experiments recently completed at the Utah station this principle has been put to the test under irrigated conditions, and it was found that the available soil fertility set free during one season by persistent hoeing reduced largely the amount of water required for each pound of dry matter—in one case nearly 20 per cent—that two or more years of fallowing reduced the water cost of dry matter one-half or more, and that the addition of commercial fertilizers to somewhat infertile soils made it possible to grow crops with very much smaller amounts of water than before. The limits of the application of this leading principle are yet to be determined, but in the West, where water is the limiting factor of crop production, any new method of conserving soil moisture is of very great importance.

The bacterial life of the soil, as affecting fertility, is also strongly influenced by irrigation. The Utah station has attempted to investigate the subject by

studying the production and movement of nitrates in irrigated soils. No very definite results have as yet been obtained beyond the general one that the periodic application of irrigation water does affect definitely the production and distribution of nitrates, and, in all probability, the producton of other soluble plant foods. An almost virgin field is opened here.

In view of the relation of available plant food to transpiration, it becomes more important than ever to determine the actual fertilizing value of the constituents of the irrigation water drawn from the chief rivers of the West. The Arizona station is notable for the work it has done on this subject. More should be done, however, in all the arid States. In connection with this phase of the work, it might be well to determine the limits of safety in the use of the numerous saline springs and creeks for irrigation purposes.

When these and other problems concerning the relationship of irrigation water to soils have been atttacked and results are being obtained, it will be found necessary to conduct soil surveys for the purpose of enabling the investigators to apply properly the conclusions obtained with type soils to the great variety under cultivation. These surveys must determine primarily the water needs of the soils, and in that respect will be wholly different from the old-fashioned soil surveys.

The work to be done in elucidating the relationship between soils and irrigation water in actual farm practice, as above outlined, leads into a large and mostly untrodden field, where the soil chemists, soil physicists, soil bacteriologists, and the engineers may labor long, from a new point of view, with profit to themselves and the irrigated section. The opportunity to enter a new field should of itself be very attractive to station workers who have hammered away these many years at the inherited, stereotyped problems.

The above-suggested soil studies in behalf of irrigation appear, no doubt, exhaustive and complex, but they are in reality less so than the investigations necessary to determine the relations between plants and water under conditions of irrigation. The yield of crops is of first importance to the farmer. It depends upon many factors, especially the total quantity of water used, the time of application, the frequency of application, and the manner of application. In general, it has been found that with little irrigation water much more grain, potatoes, sugar beets, or other crops is produced per inch than with larger quantities of water. In fact, the crop-producing value of water appears to diminish up to a definite limit; the addition of water beyond this limit causes in many cases an actual diminution of crop yield. Naturally, this is of fundamental importance in all irrigated sections, and should be given thorough investigation for all classes of soils and crops. The results obtained during the last nine years of irrigation study at the Utah station show clearly that in Utah, and undoubtedly in all the Western States, entirely too much water is used for the production of crops. A more moderate use of water, according to the findings of the experiments already conducted, would double or treble, or perhaps quadruple, the irrigated area without adding to the amount of water already stored in reservoirs and carried by canals.

The total yield of the crop is not alone affected by irrigation; the manner of growth is likewise influenced. For instance, the time of maturing may be delayed or hastened, which is well worth considering in many places where earliness or lateness determines success or failure. The relative proportions of plant parts—leaves, stems, roots, and seeds—may also be varied. In the production of wheat and other plants the seed of which is of a high value and the straw of little value, any method that will enable the farmer to increase the grain at the expense of the straw has a distinct economic value. The rate of growth of a plant, the development of its root system, and its general manner of growth are strongly influenced by irrigation. The problems of fall irrigation and the utilization of the early spring floods must be studied with reference not only to the effect upon the yield, but upon the general growth of the crop.

Next to the crop yield stands in importance, no doubt, crop quality as it is affected by irrigation. It is now well understood that the composition of plants may be varied at will, within limits yet to be defined, by varying the amount or method of irrigation. Some seven years ago the Utah station found that by regulating the amount of water applied to wheat on a certain shallow soil the protein in the grain was raised from about 15 to 26 per cent. This very large variation can, in all probability, be accomplished only under unusual soil conditions, but it shows as an extreme case the possibilities of affecting the composition of plants by irrigation. It has been stated as a law that the protein

increases as the amount of irrigation water decreases. In the study of the relation of season to grain composition this has been substantiated by many stations in all parts of the country, as evidenced in many recent bulletins. It has also been observed that sugar and starch in potatoes and sugar beets increase with increasing amounts of irrigation water and decrease with decreasing irrigation. The composition of all plant parts appears to be affected by changing irrigations. With the power of varying at will, within considerable limits, the composition of the crops produced, it should be possible for the western farmer to enter the markets with a new vigor and in successful competition with any district which does not possess the control furnished by irrigation. The coming tendency is to value foods, both for man and beast, more and more on the basis of quality. As that tendency becomes crystallized into practice the immense value to the irrigation farmer of being able to regulate, in a measure, the composition of his crops will become more evident.

In connection with the subject of the quality of irrigated crops much work needs to be done. For instance, it is not sufficient to say that wheat grown with little water is rich in protein. It must be determined, also, to what extent this difference enters into the flour made from the grains. At the Utah station a mill was installed for this purpose some six years ago, and the results already obtained are of great importance. Similarly, potatoes, carrots, cabbages, and other vegetables grown with various amounts of water should be tested for their cooking value. This would bring into service the domestic-science departments as cooperative workers in an exhaustive and scientific scheme of irrigation investigations. Still further, the plant chemist should probe into the very heart of the chemical constituents of the plants and their parts to learn whether under varying conditions of irrigation the chemical nature of the individuals roughly classed as protein, sugars, starches, and fats, is changed. To carry the work to its logical end feeding experiments should be instituted for the purpose of comparing the value of crops produced under the various methods of irrigation and with different amounts of water. It appears less important for the western stations to determine the feeding value of each kind of crop, which is being done so well by stations in other parts of the United States, than to establish the feeding value of the same crops grown under various conditions of irrigation.

Since it has been observed that the nature and growth of plants, the percentage of seeds, leaves, and stalks, and the quality itself are influenced by irrigation, the question has been repeatedly raised whether or not it is possible to breed into plants by continual growing under irrigated conditions certain definite characteristics. Whether this can be done is doubtful, but it is certainly worthy of careful investigation and opens an interesting field for the student of plant breeding.

As for the actual apparatus to be used in irrigation investigations, in Utah the main dependence has been placed upon carefully flumed farms upon which accurately measured amounts of water can be applied. To check against the results obtained on these farms a vegetation house has been employed in which pots containing different soils have been subjected to treatments very much like those given the plats in the experimental field. Further, to check against the results obtained from the flumed farms and the vegetation house, experimental farms have been established for one or two seasons in numerous places throughout the State and upon which accurately measured amounts of water could be applied. It has been a source of gratification to note the degree to which the conclusions drawn from the work on the experimental plats were corroborated by the results obtained on the larger temporary farms under new conditions in various parts of the State. Then, back of the field work have been the steadying help of the laboratory workers in the chemical, physical, and bacteriological laboratories. In the pursuit of the investigations it has been necessary from time to time to devise new apparatus, and this has been one of the most difficult tasks. I confess freely that at the Utah station we have succeeded in doing only in part what our plans contemplated some ten years ago. However, enough has been done to justify us in the belief that it would be extremely profitable to the stations and to the West to have such investigations conducted on a larger and cooperative scale.

The thing that most impresses a student of irrigation is the fact that irrigation investigations require the united effort of men of a variety of training. The irrigation engineer can do only a part of the work, though in the past it has been the custom to delegate all irrigation investigations to him. The

expert student of soils is equally important. The chemist can not be dispensed with. As the influence of irrigation on the bacterial life in the soil becomes more fully understood, the bacteriologist will be in greater demand. The plant physiologist will be required to illuminate obscure corners in the theory of transpiration and the transference and use of water within the plant. The soil physicist will be taxed to devise methods and execute surveys of the soils to be irrigated. As the work progresses other fields of investigation will come into view, and workers in other departments of science will be invited to join in the pursuit. The solution of these important irrigation problems seems, therefore, to depend primarily upon the united effort of many workers in many stations. I am not advising the organization of any more scientific associations, but it certainly would be helpful if the stations interested should call a conference, preferably under the supervision of the Office of Experiment Stations, for the purpose of discussing the great irrigation problem and laying plans whereby the work can be undertaken in good earnest. It may not be wise for any one station to attempt all the phases of the investigation. It may be better if a division of the work is made among the various stations, yet that also is a matter for discussion. I fear that until the stations unite to solve the problems of irrigation we shall make slow headway, and will not be able to keep pace with the demands made upon us as the new irrigation projects are completed by the federal and state governments and by private enterprise.

Changed conditions have brought the nation into competition with the world. The nation itself is placing more and more of its agricultural burdens upon the West. The value, as a national asset, of the deep fertile soils of the West, and the unequaled power possessed by the farmer who controls at will water, one of the four great factors of plant production, is being more clearly appreciated. Slowly, but surely the population is moving westward. The experiment stations should anticipate the future and no longer hesitate to devote a larger amount of energy and money to the elucidation of the principles underlying the ancient art of irrigation. In the attempt to establish a science of irrigation important discoveries will be made, which will benefit the whole country, and both the East and the West will say that the expenditure of time and money and human energy has been well justified.

The CHAIRMAN. In this connection I might say that in the humid regions where we formerly thought irrigation was unnecessary we find it exceedingly profitable, and these problems here being worked out so successfully in the arid region will be of great value there.

D. W. MAY, of Porto Rico. Has an investigation been made of the effect of irrigation on the bacteriological content of the soil?

J. A. WIDTSOE. I am hardly qualified to answer that question. We find that nitrates go down in the soil and come up again as the soil water goes down and up. When water is applied to the soil bacterial activity is influenced to a certain extent.

F. B. LINFIELD, of Montana. In observations upon dry farming we have found that there is a very close relation between the water supply in the soil and the nitrate content. In dry soil there is very little nitrate.

In reply to a question, J. A. Widtsoe stated that in the tests at the Utah station it was found in every case that by the addition of fertilizers to infertile soil the amount of water required for one pound of dry matter was greatly diminished. On the fertile soil the effect was not so clear. But the most interesting feature of the investigation was that by letting the soil lie fallow two or three years there was a corresponding diminution of the amount of water required for crop production.

The secretary read the following paper by E. T. Tannatt, of Montana:

IRRIGATION INVESTIGATIONS.

The investigations of the Montana Experiment Station along the lines of irrigation practice have, for the past four or five years, been conducted with the object of eliminating some of the more important difficulties encountered by the

irrigator, especially in districts where water is not secured in sufficient quantities to furnish an abundant supply at all times.

The laws of Montana rightly limit rights to "beneficial use," and it is upon that law as a basis that the station has been working, believing that "beneficial use" should apply with equal right to the transporting of the water supply, as to its actual distribution on the fields.

When the streams furnish an abundant water supply for all purposes it is oftentimes difficult and well-nigh impossible to make a community take an interest in the proper and economical use of the supply; but when the water is scarce or has to be pumped, the station has found more ready assistance and a greater willingness to profit by the advice given.

There are, we believe, a very large number of problems presented to the irrigator and the irrigation engineer which deserve careful consideration. Some of these problems will be solved by the farmers themselves in due course of time; and improvement will be made only after attending the school of practical experience, while others will require experimental research work, unless we are content to continue expending money along the same careless lines, which have so often resulted in financial losses and failures of the irrigation companies of the West.

In the early days of irrigation practice the canals and ditches were largely located and constructed without a thought as to grade or velocity, seemingly the only object being to deliver the water to the land as quickly and easily as possible. Practical experience has since demonstrated the fallacy of these methods, until at the present day an experienced engineer is employed on most of the irrigation projects.

The station, therefore, believed it right and best to investigate such problems as were considered of the most vital importance to the irrigator and State in general. We recognized that at the present time a considerable portion of the irrigated sections of Montana were suffering from an excess of water deposited in the subsoil during the irrigation season.

This could be avoided in a measure, by the proper application to the fields of irrigation waters. But we early recognized that we would encounter two great difficulties in teaching this to the farmers of the State: First, the practical irrigator has yet to learn to give the technically trained man much consideration in such matters. The practical irrigator looks at this question as he would in buying feed for his horses, namely, he must get as much for his money as possible, and if he has a greater supply than he can properly use, he can afford to waste it, as he has paid for it. He looks upon his water supply, "If a little water is a good thing, more of it is better."

To demonstrate that a less supply of water will produce better crops carries little weight, as he will credit the result, if demonstrated, to soil cultivation or weather rather than proper regulation of the water supply.

Further difficulty was also presented, as we knew that but part of the seepage difficulties could be charged to the excessive use of irrigation waters upon the fields and that, even after we had taught the proper duty of water and the farmers had followed our teachings, we would yet have a considerable portion of the difficulty not provided for.

In teaching the duty of water the station recognized that, in addition to the prejudice which the practical irrigator seems to hold against the technically trained man, the human element entered the consideration, in an effort to try and get all you can for the money. We therefore came to the conclusion that we could best teach the proper use of water by making clear to the irrigator the folly of excessive use of water and the damage due therefrom. We also recognized that not only the irrigator but the canal companies were to a very large extent equally subject to criticism, and if we were to obtain the best results for the State we must "hew true to the line" and treat the canal companies and the farmers with equal justice.

Our irrigation investigations for the past four years have, therefore, been along the lines of seepage and drainage, and we have found that not only are there lessons for the farmers and canal companies to learn, but that the irrigation engineer has many points he can study to good advantage.

In our seepage investigations we early demonstrated that the larger percentage of difficulties arising from subirrigation was chargeable to the canal companies and the owners of ditches.

Canals and ditches in the several parts of the State were investigated and their seepage losses varied from as low as one-half of 1 per cent per mile to as

high as 34 per cent per mile of the water entering the canals. These records were not taken from new canals and ditches, but from those which had been in use for from five to forty years.

From one system alone we found more than 50 per cent of the entire supply lost before reaching the lands to be irrigated. Fortunately these cases of excessive seepage losses apply to sections in the several canals; if it were not the case our canals would all be excessively short.

We are not able to harmonize the thought of "beneficial use" with the usual method of trying to convey the waters to the lands through canals and ditches constructed in gravel with the velocities so high as to absolutely prevent the deposit of silt, as also to erode the soil itself.

In many parts of the irrigated sections of the West and, in fact, in nearly every irrigated section, we observe tracts of once valuable agricultural lands rendered valueless through subirrigation and the consequent deposit of alkali. In many of the valleys of Montana this damaged land covers areas thousands of acres in extent.

Various publications upon the subject have been published in accusing the farmers of wasteful extravagance in the use of water; and the author has met representatives of some of the larger canal companies, who, pointing to some submerged tract, remarked: "It is strange that these farmers can not be made to realize the damage they cause to their properties by such wasteful use of water." Some years since, and after investigating conditions, we became convinced that it was necessary to learn more of the true cause of the difficulty and, in addition to a study of the methods for applying water to the lands, investigated the losses from the canals of several of the valleys. In one canal, about 20 miles in length, we found an actual seepage loss of 20.3 second-feet. As this canal is one of the oldest and best constructed in the State, in all probability the losses above recorded are close to a minimum as compared with other newer and more poorly constructed canals. It may be difficult for some to realize just what volume of water 20.3 second-feet of seepage represents. In order to assist in this matter, we will suppose that it were possible to collect all of this seepage into one channel and to deliver it into one reservoir without evaporation. If we consider the area of the floor of our reservoir as covering 100 acres and that the side walls of the reservoir were vertical, this amount of water would, in one year's time, fill the reservoir to a depth of 147 feet. In other words, we would have filled a reservoir 2,087 feet square and over 147 feet deep.

If we consider only the irrigation season of three months, and made a like reservoir to cover 10 acres, we would yet fill this smaller reservoir to a depth of 367.5 feet. And with all we must keep in mind that the above figures must (even under the most favorable conditions) represent the minimum seepage loss from this canal; for, if we could eliminate the drainage effect from the canal, the seepage losses would exceed the 20.3 second-feet by an unknown and possibly large amount.

It may be of interest to note that these losses, if they could be avoided, would represent a gain to the company (taking the value of the water as low as we have been able to learn of its sale in the State, \$2 per inch per season) of \$1,626, being equal to an investment of \$20,325 with interest at 8 per cent. It is also evident that it would be impossible to save absolutely all of the water included in the seepage losses. From another canal, some 16 miles in length, and which received a considerable subsurface inflow from stream crossings, we found a seepage loss of 32¼ second-feet. In another canal, 10 miles in length and in the same district, and subject to even greater subsurface inflow, we found a seepage loss of 55¾ second-feet. The losses from the two canals during one hundred days of the irrigation period furnished a volume of water capable of filling to depth of 7 feet a reservoir 2 miles square. These figures, we know, neither represent the total seepage loss from the two canals, nor the total seepage losses from the irrigation system, and yet it is capable of submerging to a depth of 7 feet over 2,500 acres of land.

The question which at once confronts the engineer is, How shall we remedy the difficulty? Like all other ills, we must first learn the cause and locate the seat of the difficulty before a remedy can be intelligently applied, and in this we find ourselves lacking proper information. We examine our reference books and reports and invariably we are advised that the average seepage loss in canals is such and such a per cent per mile. We realize fully that the seepage losses in gravel are greater than in clay, and yet little or no mention is made

of the fact in our publications. We advise our farmers and canal owners to puddle or cement-line their canals, and we are not able to intelligently advise at just what point or how far we must carry this work before it ceases to give proper financial return. We are lacking at the present time reliable data relative to the seepage losses from canals constructed of the various materials and the effect of age in reducing these losses under varying velocities. With proper information along these lines the irrigation engineer could intelligently and economically provide against seepage losses at the time of construction. The farmer or canal owner could ascertain within a reasonable degree of accuracy where it would pay to expend labor in making the ditch or canal more water-tight than provided by the materials with which the canal is constructed. Tables of such a character would be of value not only to the engineer but to the canal owner and irrigator, especially if we supplemented the same with a table showing the volume of the losses in terms which could be appreciated by the laymen. The term "second-foot" or "cubic feet per second" carries little information as to quantity when read by the average person, while the term "miner's inch" is even more indefinite.

The author recognizes in seepage losses what he believes to be one of the greatest menaces to the successful future of the irrigated interests, and is of the opinion that little good will result in attempting to correct the difficulty through teaching "duty of water." The state laws which limit the water rights to beneficial use are steps in the right direction, and should be supplemented by other laws penalizing canal companies and ditch owners when excessive seepage losses occur in canals and ditches. To properly make such a law effective, we must know more of the actual seepage losses in the several classes of materials. The author has found in his investigations canals to which could properly be charged a very large amount of damage to lands below on account of seepage, and yet these same canals actually carried a greater volume of water 15 miles below than at the headgates. These canals, while subject to heavy seepage losses, were serving as drains for irrigated lands above.

In one case in particular, we found 97 second-feet of water entering the headgates, while 15 miles below a flow of 135 second-feet was recorded. A law penalizing seepage losses would have been inoperative against this canal unless the canal was specially examined.

From the engineering irrigation investigations conducted by the experiment station, the author is of the opinion that far greater general good would result if we confined our studies less to the farmer himself and more closely to the conditions surrounding him and then made these conditions the object-lesson from which we are to teach.

To hold the farmer responsible for the great damage done to submerged lands and to say nothing about the losses from canals is bound to cause the farmer to distrust either our intelligence or honesty. The average farmer will give little credence to the person who demonstrates that he is not thoroughly posted in his specialty, or to the person who fears to state the facts, lest they affect the interests of some company or corporation.

J. D. Towar, of Wyoming. There is one point that has not been discussed in connection with these two papers which impresses me very forcibly, and that is the point that Doctor Widtsoe hinted at as to the formation of perhaps another society for the promotion of irrigation science. I believe that in view of the many problems that we have in the States where irrigation is practiced there is a real need for the irrigation engineers, directors of experiment stations, and others to get together and form, perhaps, a section of this association or form a new association for the studying and working out of these various problems. The paper that Doctor Widtsoe has given us has outlined a large number of important experiments, and no institution in the West is capable of taking up all of these. It seems to me that by the stations getting together some of this field could be divided up and some very important scientific work carried on, particularly under the Adams fund. I want to throw out this special suggestion. It seems to me it is something we ought to materialize in the near future.

F. B. Linfield. I have been thinking about this question of irrigation a great deal during the sixteen years that I have lived in this western country. I agree

with Doctor Widtsoe on one point, viz, that in our experimental work we have been considering this matter of irrigation in many places from the wrong standpoint. In other words, there are two distinct fields. The one is the field of the engineer, the other is the field of the man who has had his educational foundation in biology, chemistry, and agricultural practice. One is the question of getting water to the land and the other is applying the water to the land. The one is making available the stored water supply; the other is using water to grow crops. There seems to me, therefore, to be some need for reorganization of our methods of attacking this problem. In our work we are considering the application of water to the land as an agricultural problem, but associated with the chemist and the biologist. It is the question of the relation of water to the soil and the crop. The other question is one of engineering construction, of getting water to the land and preventing or correcting evils that come from its excessive use. This requires not a biological or chemical, but an engineering training. In the past we have been trying to combine both of these lines of work, and I have sometimes questioned whether we have made the progress we should had we had another point of view.

In my studies in the East the all important question in crop production was soil fertility. My observation and experiences in the West has led me to give the superior consideration to the water supply. This is not because soil fertility is not important, but because the availability of the soil fertility depends upon the water supply. In the dry country a water supply we must have, for without a water supply we can not use the fertility. In our investigations on the dry farms in Montana we have obtained more bushels of grain from two crops grown in alternate years than we have got from four crops grown continuously on the land. We have tried to find an explanation for this, and our studies have led us to believe that the size of the crop depends mainly upon two things. First, the available water supply, and, second, the available fertility. But on the dry land if we do not give special attention to preserving the water supply in the soil and so making conditions favorable to the bacterial growth, and to the chemical changes in the soil, there is no preparation of the plant food and the result is much reduced yields.

Election of Officers of the Section and Members of the Executive Committee.

The committee on nominations being absent, after a brief session of the section as a committee of the whole, the secretary announced the selection by the committee of the following officers for the ensuing year: For chairman of the section, F. B. Linfield, of Montana; secretary, H. L. Russell, of Wisconsin; members of the executive committee, W. H. Jordan, of New York, and C. F. Curtiss, of Iowa; additional member of the program committee, W. H. Beal, of Washington, D. C.

The section then adjourned sine die.

[Bull. 228]

INDEX OF NAMES.

O

THE AGRICULTURAL EXPERIMENT STATIONS.

ALABAMA—
  College Station: *Auburn;* J. F. Duggar.[a]
  Canebrake Station: *Uniontown;* F. D. Stevens.[a]
  Tuskegee Station: *Tuskegee;* G. W. Carver.[a]

ALASKA—*Sitka:* C. C. Georgeson.[b]

ARIZONA—*Tucson:* R. H. Forbes.[a]

ARKANSAS—*Fayetteville:* C. F. Adams.[a]

CALIFORNIA—*Berkeley:* E. J. Wickson.[a]

COLORADO—*Fort Collins:* C. P. Gillette.[a]

CONNECTICUT—
  State Station: *New Haven;* E. H. Jenkins.[a]
  Storrs Station: *Storrs;* L. A. Clinton.[a]

DELAWARE—*Newark:* Harry Hayward.[a]

FLORIDA—*Gainesville:* P. H. Rolfs.[a]

GEORGIA—*Experiment:* Martin V. Calvin.[a]

GUAM—*Island of Guam;* Jno. B. Thompson.[b]

HAWAII—
  Federal Station: *Honolulu;* E. V. Wilcox.[b]
  Sugar Planters' Station: *Honolulu;* C. F. Eckart.[a]

IDAHO—*Moscow:* W. L. Carlyle.[a]

ILLINOIS—*Urbana:* E. Davenport.[a]

INDIANA—*Lafayette:* A. Goss.[a]

IOWA—*Ames:* C. F. Curtiss.[a]

KANSAS—*Manhattan:* E. H. Webster.[a]

KENTUCKY—*Lexington:* M. A. Scovell.[a]

LOUISIANA—
  Sugar Station: *Audubon Park, New Orleans.*
  State Station: *Baton Rouge.*
  North Louisiana Station: *Calhoun.*
  Rice Station: *Crowley;* W. R. Dodson (*Baton Rouge*).[a]

MAINE—*Orono:* C. D. Woods.[a]

MARYLAND—*College Park:* H. J. Patterson.[a]

MASSACHUSETTS—*Amherst:* W. P. Brooks.[a]

MICHIGAN—*East Lansing:* R. S. Shaw.[a]

MINNESOTA—*University Farm, St. Paul:* A. F. Woods.[a]

MISSISSIPPI—*Agricultural College:* J. W. Fox.[a]

MISSOURI—
  College Station: *Columbia;* F. B. Mumford.[a]

MISSOURI—Continued.
  Fruit Station: *Mountain Grove;* P. Evans.[a]

MONTANA—*Bozeman:* F. B. Linfield.[a]

NEBRASKA—*Lincoln:* E. A. Burnett.[a]

NEVADA—*Reno:* J. E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* W. D. Gibbs.[c]

NEW JERSEY—*New Brunswick:* E. B. Voorhees.[a]

NEW MEXICO—*Agricultural College:* L. Foster.[a]

NEW YORK—
  State Station: *Geneva;* W. H. Jordan.[a]
  Cornell Station: *Ithaca;* H. J. Webber.[c]

NORTH CAROLINA—
  College Station: *West Raleigh;* C. B. Williams.[a]
  State Station: *Raleigh;* B. W. Kilgore.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Wooster:* C. E. Thorne.[a]

OKLAHOMA—*Stillwater:* J. A. Craig.[a]

OREGON—*Corvallis:* J. Withycombe.[a]

PENNSYLVANIA—
  State College: T. F. Hunt.[a]
  State College: Institute of Animal Nutrition; H. P. Armsby.[a]

PORTO RICO—*Mayaguez:* D. W. May.[b]

RHODE ISLAND—*Kingston:* H. J. Wheeler.[a]

SOUTH CAROLINA—*Clemson College:* J. N. Harper.[a]

SOUTH DAKOTA—*Brookings:* J. W. Wilson.[a]

TENNESSEE—*Knoxville:* H. A. Morgan.[a]

TEXAS—*College Station:* H. H. Harrington.[a]

UTAH—*Logan:* E. D. Ball.[a]

VERMONT—*Burlington:* J. L. Hills.[a]

VIRGINIA—
  Blacksburg: S. W. Fletcher.[a]
  Norfolk: Truck Station; T. C. Johnson.[a]

WASHINGTON—*Pullman:* R. W. Thatcher.[a]

WEST VIRGINIA—*Morgantown:* J. H. Stewart.[a]

WISCONSIN—*Madison:* H. L. Russell.[a]

WYOMING—*Laramie:* J. D. Towar.[a]

[a] Director. [b] Special agent in charge. [c] Acting director.

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION.

NOTE.—Publications marked with an asterisk (*) are not available for distribution.

BULLETINS.

*Bul. 36. Notes on Irrigation in Connecticut and New Jersey. By C. S. Phelps and E. B. Voorhees. Pp. 64.
*Bul. 58. Water Rights on the Missouri River and its Tributaries. By Elwood Mead. Pp. 80.
*Bul. 60. Abstract of Laws for Acquiring Titles to Water from the Missouri River and its Tributaries, with the Legal Forms in Use. Compiled by Elwood Mead. Pp. 77.
Bul. 70. Water-right Problems of Bear River. By Clarence T. Johnston and Joseph A. Breckons. Pp. [illegible]
*Bul. 73. Irrigation in the Rocky Mountain States. By J. C. Ulrich. Pp. 64.
*Bul. 81. The Use of Water in Irrigation in Wyoming. By B. C. Buffum. Pp. 56.
*Bul. 86. The Use of Water in Irrigation. Report of investigations made in 1899, under the supervision of Elwood Mead, Expert in Charge, and C. T. Johnston, assistant. Pp. 253.
*Bul. 87. Irrigation in New Jersey. By Edward B. Voorhees. Pp. 40.
*Bul. 90. Irrigation in Hawaii. By Walter Maxwell. Pp. 48.
*Bul. 92. The Reservoir System of the Cache la Poudre Valley. By E. S. Nettleton. Pp. 48.
*Bul. 96. Irrigation Laws of the Northwest Territories of Canada and of Wyoming, with Discussions by J. S. Dennis, Fred Bond, and J. M. Wilson. Pp. 90.
*Bul. 100. Report of Irrigation Investigations in California, under the direction of Elwood Mead, assisted by William E. Smythe, Marsden Manson, J. M. Wilson, Charles D. Marx, Frank Soulé, C. E. Grunsky, Edward M. Boggs, and James D. Schuyler. Pp. 411.
*Bul. 104. Report of Irrigation Investigations for 1900, under the supervision of Elwood Mead, Expert in Charge, and C. T. Johnston, assistant. Pp. 334. (Separates only.)
*Bul. 105. Irrigation in the United States. Testimony of Elwood Mead, Irrigation Expert in Charge, before the United States Industrial Commission, June 11 and 12, 1901. Pp. 47.
Bul. 108. Irrigation Practice Among Fruit Growers on the Pacific Coast. By E. J. Wickson. Pp. 54.
*Bul. 113. Irrigation of Rice in the United States. By Frank Bond and George H. Keeney. Pp. 77.
Bul. 118. Irrigation from Big Thompson River. By John E. Field. Pp. 75.
*Bul. 119. Report of Irrigation Investigations for 1901, under the direction of Elwood Mead, Chief. Pp. [illegible] (Separates only.)
Bul. 124. Report of Irrigation Investigations in Utah, under the direction of Elwood Mead, Chief, assisted by R. P. Teele, A. P. Stover, A. F. Doremus, J. D. Stannard, Frank Adams, and G. L. Swendsen. Pp. 330.
*Bul. 130. Egyptian Irrigation. By Clarence T. Johnston. Pp. 100.
*Bul. 131. Plans of Structures in Use on Irrigation Canals in the United States, from drawings exhibited by the Office of Experiment Stations at Paris, in 1900, and at Buffalo, in 1901, prepared under the direction of Elwood Mead, Chief. Pp. 51.
*Bul. 133. Report of Irrigation Investigations for 1902, under the direction of Elwood Mead, Chief. Pp. [illegible]
Bul. 134. Storage of Water on Cache la Poudre and Big Thompson Rivers. By C. E. Tait. Pp. [illegible]
*Bul. 140. Acquirement of Water Rights in the Arkansas Valley, Colorado. By J. S. Greene. Pp. [illegible]
*Bul. 144. Irrigation in Northern Italy—Part I. By Elwood Mead. Pp. 100.
*Bul. 145. Preparing Land for Irrigation and Methods of Applying Water. Prepared under the direction of Elwood Mead, Chief. Pp. 84.
*Bul. 146. Current Wheels: Their Use in Lifting Water for Irrigation. By Albert Eugene Wright. Pp. [illegible]
Bul. 148. Report on Irrigation Investigations in Humid Sections of the United States in 1903. Pp. [illegible]
*Bul. 157. Water Rights on Interstate Streams. By R. P. Teele and Elwood Mead. Pp. 118. (Separates only.)
*Bul. 158. Report on Irrigation and Drainage Investigations, 1904. Under the direction of Elwood Mead, Chief. Pp. 755. (Separates only.)
*Bul. 167. Irrigation in the North Atlantic States. By Aug. J. Bowie, jr. Pp. 50.
*Bul. 168. The State Engineer and His Relation to Irrigation. By R. P. Teele. Pp. 99.
Bul. 172. Irrigation in Montana. By Samuel Fortier, assisted by A. P. Stover and J. S. Baker. Pp. [illegible]
Bul. 177. Evaporation Losses in Irrigation and Water Requirements of Crops. By Samuel Fortier. Pp. 64.
Bul. 179. Small Reservoirs in Wyoming, Montana, and South Dakota. By F. C. Herrmann. Pp. [illegible]
*Bul. 181. Mechanical Tests of Pumping Plants in California. By J. N. Le Conte. Pp. 72.
Bul. 183. Mechanical Tests of Pumps and Pumping Plants Used for Irrigation and Drainage in Louisiana in 1905 and 1906. By W. B. Gregory. Pp. 72.
Bul. 188. Irrigation in the Yakima Valley, Washington. By S. O. Jayne. Pp. 89.
Bul. 190. Irrigation in Northern Italy—Part II. By Elwood Mead. Pp. 86.
Bul. 191. Tests of Internal Combustion Engines on Alcohol Fuel. By C. E. Lucke and S. M. Woodward. Pp. 89.

 [Continued on third page of cover.]

1284 Issued December 30, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN 229.

A. C. TRUE, Director.

DELIVERY OF WATER TO IRRIGATORS.

BY

FRANK ADAMS,

Irrigation Manager, in Charge of Work in California.

PREPARED UNDER THE DIRECTION OF

SAMUEL FORTIER,

Chief of Irrigation Investigations.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1910.

OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.
E. W. ALLEN, Assistant Director.

IRRIGATION INVESTIGATIONS.

SAMUEL FORTIER, Chief.
R. P. TEELE, Assistant Chief.

IRRIGATION ENGINEERS AND IRRIGATION MANAGERS.

A. P. STOVER, Irrigation Engineer, in charge of work in Oregon.
C. E. TAIT, Irrigation Engineer, in charge of work in southern California.
S. O. JAYNE, Irrigation Manager, in charge of work in Washington.
FRANK ADAMS, Irrigation Manager, in charge of work in California.
W. W. MCLAUGHLIN, Irrigation Engineer, in charge of work in Utah.
P. E. FULLER, Irrigation Engineer, in charge of work in Arizona and of power investigations.
W. L. ROCKWELL, Irrigation Manager, in charge of work in Texas.
D. H. BARK, Irrigation Engineer, in charge of work in Idaho.
MILO B. WILLIAMS, Irrigation Engineer, in charge of work in humid sections.
V. M. CONE, Irrigation Engineer, in charge of work in central California.
C. G. HASKELL, Irrigation Engineer, in charge of rice investigations.
FRED G. HARDEN, Scientific Assistant.
R. D. ROBERTSON, Assistant Irrigation Engineer.
J. W. LONGSTRETH, in charge of work in Kansas.

COLLABORATORS.

O. V. P. STOUT, University of Nebraska, in charge of work in Nebraska.
GORDON H. TRUE, University of Nevada, in charge of work in Nevada.
W. B. GREGORY, Tulane University of Louisiana, in charge of rice irrigation in Louisiana and Texas.
F. L. BIXBY, New Mexico Agricultural College, in charge of work in New Mexico.

IRRIGATION FARMERS.

JOHN H. GORDON, R. G. HEMPHILL, W. H. LAUCK, R. E. MAHONEY, and JOHN KRALL, Jr.

[Bull. 229]

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., April 30, 1910.

Sir: I have the honor to transmit herewith a report on the delivery of water to irrigators, prepared by Frank Adams under the direction of Samuel Fortier, chief of irrigation investigations. The successful operation of an irrigation enterprise depends very largely upon the system adopted for distributing water to the irrigators. No single factor adds more to the chances of success for both the canal owners and the farmers than an assurance that water will be delivered when it is due. In this report Mr. Adams describes the systems adopted on some forty or fifty irrigation enterprises throughout the West, in the hope that the description will lead to the more general adoption of efficient systems of distribution, that it will impress irrigators and irrigation managers with the value of measuring the water used, and that it will create a greater general interest in the efficient management of irrigation enterprises. Mr. Adams wishes to acknowledge the assistance of several members of the field force of this Office, as well as that of J. C. Wheelon, E. R. Morgan, R. L. Parshall, C. G. Jones, W. E. Bowen, F. G. Tracy, S. W. Cressey, and H. J. Quayle.

It is recommended that this report be published as a bulletin of this Office.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

DELIVERY OF WATER TO IRRIGATORS.

INTRODUCTION.

This bulletin is intended to give a description and review of the best features of the delivery of water to irrigators as disclosed by practice in the irrigated sections of the United States. It is not a complete treatment of the subject, because nearly every canal presents interesting points of difference from other canals, and the data on which it is based come from but forty or fifty systems. However, the systems from which information has been drawn are among the best managed in this country, and they at least show the best typical practice in this important branch of canal management.

More of the systems selected for description are located in California than in any other State. This is because it has been possible to gather data about more systems in California than in any of the other States, and not necessarily because more can be learned from California practice than from practice elsewhere. However, outside of the canals operated by the United States Reclamation Service, the canals around Riverside, Cal., have the most complete systems of delivery to be found in this country; yet the delivery systems there are relatively no more complete than those, for instance, on the Consolidated Home Supply and Larimer County canals, in Colorado, or on the Bear River Canal, in Utah. Under the Riverside and other southern California canals water for irrigation has reached its highest value in this country, and it is natural that more attention should be given there to efficient management than on canals where water has a lower duty and is less valuable.

In addition to the 11 California canals whose delivery systems are described, North Poudre, Larimer County, Consolidated Home Supply, and Rockyford canals, in Colorado; Wheatland Canal, in Wyoming; the Farmers' Canal, in Montana; Upper, South Jordan, Utah and Salt Lake, Davis and Weber Counties, and Bear River

canals, in Utah; Nampa-Meridian Irrigation District Canal, in Idaho; Sunnyside Canal, in Washington; two small canals in Hood River Valley, in Oregon; Truckee-Carson irrigation project, in Nevada; Tempe Canal, in Arizona; and Northern and Pecos canals, in New Mexico, are included.

Field data were gathered during the irrigation season of 1908 from all of these canals and from those included from California. Besides, the irrigation reports of the Office of Experiment Stations were drawn upon for many suggestions, pertinent to the subject, that have been included in them from time to time, and notes taken in the field prior to beginning this bulletin were used whenever pertinent.

THE IMPORTANCE OF WATER DELIVERY.

After a canal is completed it is found that questions yet remain for decision that are far more perplexing than the mere construction of ditches. Aside from individual or small partnership ditches, probably no canal has been constructed in this country of which this has not been true. How to manage a canal so that each irrigator shall receive water in the amount and at the time required by his crops; how to divide water so that each irrigator shall receive the amount to which his water-right contract or his interest in the canal entitles him; how to organize a force and a system for water delivery that will accomplish both of these results without friction and at a cost irrigators will pay, are questions that no canal management has been able to settle except by long and costly experience. Yet these are questions the solution of which in a large measure determines the success or failure of a system.

While practically all canals have more or less satisfactory systems of water delivery, those on some canals are very much better than on others, and probably on few if any canals are those who are charged with water delivery fully satisfied with the methods in use. Every canal superintendent or manager realizes that his biggest problem is the measurement and delivery to the farmers of the water carried in his canal, and all of them eagerly seek information about the delivery systems used elsewhere. Every such official realizes that irrigators know only one test of successful canal operation—an ample water supply when and where needed. Especially regarding the details of water delivery—methods and devices for measurement, books for keeping field notes, forms for making reports and keeping records, plans of rotation or continuous delivery, and kindred questions—information is most eagerly sought. It is for this reason that this bulletin is wholly confined to the presentation of such information.

SYSTEMS USED ON TYPICAL ENTERPRISES IN CALIFORNIA.

THE GAGE CANAL COMPANY.

The plan of water delivery used on the Gage Canal at Riverside, Cal., is perhaps better known than any other in this country. The water carried by it has the exceptional agricultural value of $1,000 per miner's inch, and the need for accurately measuring the water and keeping records of its use has never been questioned.

The canal is controlled and managed by the Gage Canal Company. In addition to this company there are several entirely separate interests concerned in the delivery of water to irrigators, of which the largest and most important are the East Riverside Water Company and the San Jacinto Water Company. The former comprises the holders of 696 inches of water[a] granted by the Gage Canal Company to Mathew Gage. This company has issued its own stock in exchange for these rights and controls the distribution to the users of all the water drawn in section 2, comprising the second 5 miles of the main canal. The Gage Canal Company delivers all the water drawn from section 3, comprising Arlington Heights. The San Jacinto Water Company receives a small supply at the lower end and delivers it independently of either of the other companies. The East Riverside company pays its proportion of the expense of maintaining and operating the canal in sections 1 and 2 to the Gage Canal Company, which pays all the bills pertaining to the expense of the system and prorates them among the small interests. The irrigators in Arlington Heights own stock in the Gage Canal Company and pay their respective shares for maintaining and operating the canal.

The water supply for the Gage Canal is derived from flowing artesian wells in the bed of Santa Ana River and from wells pumped by a number of electric pumping plants. The main canal is 20.16 miles long. There are 22 pressure pipe lines, averaging 1.5 miles in length, supplying Arlington Heights. The main pipe lines are of riveted steel varying from 10 to 6 inches in diameter. The branches are of riveted steel also, 6, 5, and 4 inches in diameter. In addition to the pressure pipes of riveted steel, a few blocks close to the canal receive water from concrete pipes not under pressure. The East Riverside Water Company has 30 open laterals averaging 0.5 mile in length, and 2 pressure pipe lines of riveted steel varying from 12 to 4 inches in diameter, each about 5,000 feet long. The remainder of the system is covered by gravity lines of cement and vitrified clay pipes,

---

[a] The legal miner's inch in California is one-fortieth of a cubic foot per second. The customary miner's inch and the one which enters into most of the old contracts in southern California is one-fiftieth of a cubic foot per second. Where the miner's inch is used in this bulletin in describing the systems of southern California the latter is meant.

ranging from 12 to 6 inches in diameter. The gravity lines have few laterals and usually each covers 1 holding.

The water right under these systems is 1 miner's inch (4-inch pressure), or 9 gallons per minute for each 5 acres. The amount required for the planted lands to date is about 1,740 miner's inches, there being 8,684.40 acres irrigated under the entire canal, 3,484.40 of which are in the district controlled by the East Riverside Water Company.

The main irrigation season begins in April or May and continues to November, the heaviest application being made in the early spring. During dry years considerable water is run from November to May.

MAINTENANCE AND OPERATION.

An engineer is at the head of all deliveries and of all maintenance and operation. The force under him is enumerated in full below, the duties and salaries of each man being stated. While this force attends to both canal maintenance and operation it is concerned chiefly with water delivery.

For the water sources, headgates, section 1 and part of section 2, comprising the upper 5 miles of the main canal, the following are employed:

(*a*) A superintendent of water sources. Salary $125 per month; not an engineer.

(*b*) Four men to care for pumping plants, at $2.25 per day each. These men visit the 12 pumping plants at intervals of one and one-half hours both day and night.

(*c*) Carpenter and handy man for repairs, at $2.50 per day.

(*d*) One man, at $1.75 per day, to care for delivery to the Hunt & Cooley ditch, clean canal of weeds, and make periodical visits to the flumes in the upper section of the canal, a distance of 5 miles from headworks.

For the East Riverside section, the lower end of section 2, the following are employed:

(*a*) A head zanjero, at $115 per month, with no conveyance furnished. Reports to the office of the company at Riverside immediately after noon daily and receives orders for water, left there by telephone or in person. Attends to delivery of water from the lower 4 or 5 miles of main canal in section 2 and is responsible for maintenance of this portion of the canal.

(*b*) One assistant zanjero, at $90 per month, who patrols the upper 3 miles of canal and delivers 235 inches to irrigators, including 35 inches to the Artesia Water Company.

(*c*) One man to attend to canal cleaning, at $1.75 per day.

For Arlington Heights section (sec. 3) the following are employed:

(*a*) A head zanjero, at $150 per month, with no conveyance furnished. He oversees all delivery in section 3, receives reports from

the assistant zanjeros, and makes all reports to the engineer at Riverside. He is responsible, also, for the condition of the canal and pipe lines in his section.

(*b*) Two assistant zanjeros, at $85 per month each, and no conveyances furnished. Each makes deliveries within his section of the canal. This, however, is necessary only during the summer months; during the remainder of the season the head zanjero takes part of the work and one of the assistants the balance.

(*c*) One man, at $3.25 per day, and an assistant, at $1.75 per day, to care for pipe lines and hydrants under the direction of the zanjeros. These men are employed about ten months in the year.

(*d*) Two Japanese, at $1.75 per day, who report to the head zanjero three times daily the amount of water entering Arlington Heights section and discharged to the San Jacinto Water Company, and the amount of water in the lower section of the canal.

(*e*) Four Japanese, at $1.75 per day each, employed during six months of each year to clean canals of grass and other vegetable growth.

(*f*) One night man, a Japanese, at $1.75 per day, whose duty it is to take out of the canal the moss that is collected by a grating about 1,500 feet above the lower end of the canal and to keep clean a screen at the lower end of the canal.

PLAN OF DELIVERY.

Arlington Heights section.—Water is delivered in the Arlington Heights section principally through pressure pipes of riveted steel, each main pipe line covering two tiers of 10-acre tracts, which are laid out in regular blocks, the lots being intersected at regular intervals by streets and avenues. Each irrigator is entitled to the equivalent of a continuous flow of one-fifth miner's inch per acre, but as it would be impracticable to handle such a flow, water is allowed to accumulate and is delivered in rotation. About 80 or 85 per cent of the irrigators permit it to accumulate for forty-five days, a few irrigate every sixty days, and the rest irrigate every thirty days. The owner of a 10-acre tract whose share of water has been accumulating for sixty days is entitled to a 30-inch flow for ninety-six hours. Except in the spring, when the land is relatively loose from plowing, this amount can not be held on the land so long, and consequently few irrigators use their full allowance of water. Water is delivered on all parts of the system at the same time, 25 or 30 users receiving water at the same time. When an irrigator desires water he makes written application to the company on forms furnished to him. The by-laws of the company (Art. IX, sec. 2) provide that "he shall give the corporation at least four days' notice of such desire and accept the water on any day or days that the company

may be able to arrange for the supply thereof." The canal company will not recognize orders received in any other form and will receive orders only through the office. The orders received at the office are segregated by zanjeros' districts, the chief zanjero retaining those which he will personally fill and giving to the assistant zanjeros those for their respective districts. The company acknowledges receipt of orders on postal cards, stating when water will be delivered. The forms of application and receipt are as follows:

Form of order for water from the Gage Canal Company.

Date ...., 190...

No. of inches........................

Block .... Lot. ....

From ....

To ....

Water Order. RIVERSIDE, CAL., ..., 191—.

THE GAGE CANAL COMPANY.

Please deliver ...... inches of water for use of lots ...., block ...., commencing on the morning of ...., the .... day of ...., 190..., for .... days.

(Signature.) ....

The company will not undertake to deliver water unless this form, properly filled up and signed, is left at the office of the company, 646 Seventh street, at least four (4) days before the water is required. Water will be delivered to shareholders in accordance with Section II of Article IX of the company's by-laws, each order having precedence according to the date of its delivery at the company's office as above.

N. B.—Anyone found tampering with the hydrants, measuring boxes, or any of the company's property will be prosecuted under sections 469, 592, 625 of the penal code.

Form used by the Gage Canal Company for notifying irrigators of time water will be delivered.

RIVERSIDE, CAL., ..., 191...

DEAR SIR: Your water order of ...... received to-day. Water will be delivered ....

THE GAGE CANAL COMPANY.

Zanjero's office hours: 6 to 6.30 a. m.; 1.15 to 1.45 and 6.30 to 7 p. m. Kindly phone if necessary during above hours.

Sections of the canal about 1,500 feet above the lower end have been enlarged and cement lined to form equalizing basins to overcome the fluctuations so often found at the lower ends of canals. They are large enough to hold a flow of 60 inches for three days, and have been found to insure better service to the lower irrigators and permit of a more uniform flow to the San Jacinto Water Company.

The East Riverside Water Company.—At the beginning of each season the secretary of the East Riverside Water Company gives a statement to the head zanjero showing the amount of water to which each user is entitled during the ensuing season. The zanjero then arranges with the users as to what day or days of each month they desire to receive water, and the same days are held throughout the season, each irrigator receiving water every thirty days. The regularity of the schedule is not allowed to be broken by the last day in a 31-day month, but during that day the water either is run into the reservoirs or a little extra supply is given to those who for any reason have not received a full share. Each day at noon the assistant zanjero reports to the head zanjero the amount of water needed to

supply the users in his district the next day. The head zanjero states this amount, together with what his own district will require, to the head zanjero of the Gage Canal Company. Each irrigator gives written notice to the zanjero of the amount of water desired and for what part of his allotted period it is desired. The notices are not required to be sent through the office of the company, as in the Arlington Heights section, but are taken by the head zanjero on his daily visit and distributed between the assistant zanjeros and himself for filling. No rules or regulations have been issued by the company for the guidance of the irrigators or the zanjeros, but the zanjeros have been allowed to work out a satisfactory system, and they are supported by the directors of the company. As in the Arlington Heights section, deliveries are made only for periods of twenty-four hours or multiples thereof. The zanjeros do not make changes in the delivery at night under either of these systems.

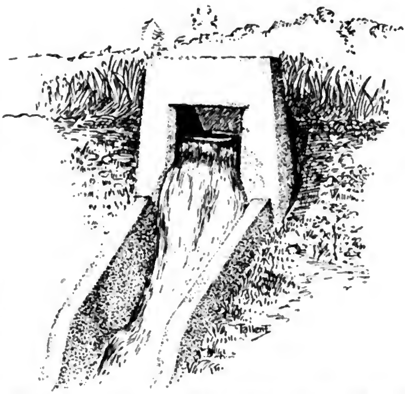

FIG. 1.—Concrete hydrant and measuring weir used by Gage Canal Company.

Measuring devices.—The first point of measurement on the main canal of the Gage company is at the township line, 5 miles below the headgate, where there is a rectangular weir with a crest length of 160 inches and an automatic water register. In addition to the continuous record of the water register, three readings of the amount of water passing over the weir are taken daily and reported to the superintendent of water sources. The next point of measurement is at weir No. 2, where water is delivered to Arlington Heights (sec. 3) over a 100-inch rectangular weir with a register. The third point is at the lower end of the canal, where water is delivered to the San Jacinto Water Company over a 20-inch rectangular weir provided with a water register. At the head of each main lateral, both in the East Riverside and Arlington Heights sections, there is a 20-inch rectangular weir, on which measurements are made twice daily. At each point of delivery on Arlington Heights there is a 10-inch rectangular weir set in the side of a cement hydrant box (fig. 1). In the section cov-

ered by the East Riverside Water Company there is a 10-inch or a 15-inch rectangular weir wherever a branch lateral leaves the main lateral, and a hydrant box at each point of delivery to irrigators. These boxes are open on top and have the weirs set in the center of a cement partition. On Arlington Heights the flow into the main pipes and also into the hydrants is controlled by regular low-down water-works valves.

RECORDS, FORMS, AND CHARGES.

A complete record of water delivery is kept by the Gage Canal Company, but none is kept by the East Riverside Water Company, except notes of daily deliveries made by the zanjeros in scratch books furnished by themselves and never turned in to the office. On Arlington Heights each zanjero enters all deliveries in a scratch book, which is not turned in to the company, and from this makes up a daily report in duplicate on the form printed below, sending the originals to the office at Riverside and retaining the duplicates.

Form of zanjeros' daily reports used by the Gage Canal Company.

GAGE CANAL COMPANY.

Zanjero's Daily Report.

Date, - ——, 190—.

Trust Co.			Orange Co.			Other growers.				Remarks.
Lot.	Block.	Inches.	Lot.	Block.	Inches.	Name.	Lot.	Block.	Inches.	

Water used above weir No. 2, ——— inches.
Water passing weir No. 2, ——— inches.

Total, ——— inches.

——— ————, *Zanjero.*

A number of years ago a ledger was started by the Gage Canal Company and kept for a year or two, in which a complete record of the deliveries to each irrigator was entered from the zanjeros' daily reports. The company has come to realize that this record is very valuable, and during the season of 1908 it entered the records for the years during which the ledger was not used. The intention is to maintain the ledger complete hereafter, as it will require not more than fifteen minutes each day to make the entries. The ledger sheets are 17 by 24 inches, and each sheet has a space for the records of delivery to 48 irrigators for twelve months. On these sheets the names of the irrigators are entered, with the exact location by lot and block and the area of the holdings, the shares of stock owned by each, the day water was turned on each month, the number of days it ran, the date it was turned off, and the total amount delivered.

The cost of water delivery and distribution by the Gage Canal Company on Arlington Heights during the past few years has ranged from 50 to 65 cents per acre. In 1901 it was 64 cents; in 1903, 51 cents; in 1904, 54 cents; in 1905, about 52 cents; in 1906, about 47 cents; and in 1907, about 53 cents. This included about two-thirds of the salary of the secretary and the salaries of the zanjeros, but no part of the salary of the engineer. In the section operated by the East Riverside Water Company the total expenses charged to water delivery in 1908 were $3,310, or an average of about 95 cents per acre for the entire 3,484.40 acres supplied.

THE RIVERSIDE WATER COMPANY.

Another important system at Riverside is that of the Riverside Water Company, which irrigates 6,500 acres of citrus orchards, 1,500 acres of alfalfa, 200 to 300 acres of grain in dry years, and 500 acres of miscellaneous crops. It receives water from Warm Creek, artesian wells, and pumps, and has a maximum flow in its two main branches of 3,000 miner's inches, or 60 cubic feet per second. This is maintained with very little change throughout the irrigation season. The larger branch, known as the Upper Canal, is 19 miles long and the smaller branch, known as Lower Canal, 12 miles long. Leading from these two branches are approximately 40 miles of laterals, consisting of both open ditches and pipe lines. About 750 irrigators are supplied with water.

PLAN OF DELIVERY.

Water delivery on this system is in charge of a superintendent, who attends also to the maintenance of the canal and pipe lines and receives a salary of $125 per month. Under him, in direct charge of delivery, is a head zanjero at $120 per month and three assistant zanjeros at $108 per month. One of the zanjeros is employed but eight months in the year, and each furnishes and feeds two horses. For the purpose of delivery the system is divided into four districts. One zanjero covers Upper and Lower canals for a distance of about 10 miles on each canal; the next, about 3.5 miles on each canal; the third, about 3 miles on each canal to the end of one; and the fourth, the remaining canal to its lower end, a distance of 9 miles. Each zanjero, except the one on the upper section, receives orders and makes reports by telephone at noon of each day. The one on the upper section receives his orders and makes his reports daily at the office in Riverside in person.

The basis of water delivery followed by this company differs entirely from that of either of the companies described previously. No water is delivered unless applied for in writing and paid for in

advance of delivery. The users, instead of being restricted to specific amounts of water at regular intervals, may receive it whenever and to whatever extent desired except in times of unusual shortage, when the supply is prorated according to the number of shares held. The rules of the company require that a notice of contemplated prorating must be published at least thirty days before it is begun. To govern the matter of orders for water and payments therefor, the following rules have been adopted and are strictly enforced:

(1) Orders must be placed in the office of the company three full days before the date of delivery.

(2) Continued orders must be placed in the office, or with the zanjero in charge, at least twenty-four hours before the expiration of the preceding order.

(3) Water will be charged at the rate prevailing at the time of delivery.

(4) Those having water paid for in advance must give the same notice as others, either at the office of the company or to the zanjero in charge.

(5) If water is sold at a less price than the rate fixed by the city trustees, the price may be advanced at any time without notice, and all water run thereafter shall be charged at full rates.

(6) Zanjeros are instructed to receive no money for water nor to receive water orders, except continued orders. The company will not be responsible for money or orders unless taken at the office of the company.

Every day during the irrigation season the total flow received into the system is divided among the zanjeros, according to the orders received, each taking the proportion to which he is entitled as nearly as he can without measurement. Long practice has enabled the zanjeros to do this with approximate accuracy. Each zanjero delivers to about 15 irrigators daily, varying from 10 to 50 inches to each. Usually 10 inches is furnished for each one for twenty-four hours every four or five weeks.

The Riverside Canal has the following devices for water measurement: A rectangular weir and Watson water register at the head of the main canal, to measure the supply from both surface and artesian sources; a 48-inch rectangular weir at each pumping plant, over each of which there is an average flow of 200 miner's inches; and a box for measuring miner's inches, at the head of each main lateral and at each point of delivery to users, where there is sufficient fall for its use (fig. 2). Where the fall is not sufficient the laterals have been rated with a current meter, and in some cases a scale has been attached to the box showing the flow in inches at different depths.

RECORDS AND CHARGES.

The records of water flow and delivery kept by this company consist only of the register sheets taken from the water registers at the head of the canal and the zanjero's reports of daily delivery, submitted by telephone. No records are kept of the flow in the main

laterals. This flow varies from day to day and during the day as required to fill orders. No report forms are used for measurements taken by the zanjeros, and no weekly reports are filed in the office.

From 1885 to 1888 water was sold at a flat charge of 7.5 cents per 24-hour inch; in 1888 the charge was raised to 10 cents, in 1898 to 15 cents, and in 1900 to 25 cents. In 1903 the company instituted a schedule of rates, varying according to season, on the theory that water is more valuable when scarce than when plentiful. The schedule of charges per 24-hour inch since that time has been as follows: July 15 to October 31, 25 cents; November 1 to February 28, 10 cents; March 1 to May 31, 15 cents; June 1 to July 15, 20 cents. With a uniform flow throughout the season the average charge per 24-hour

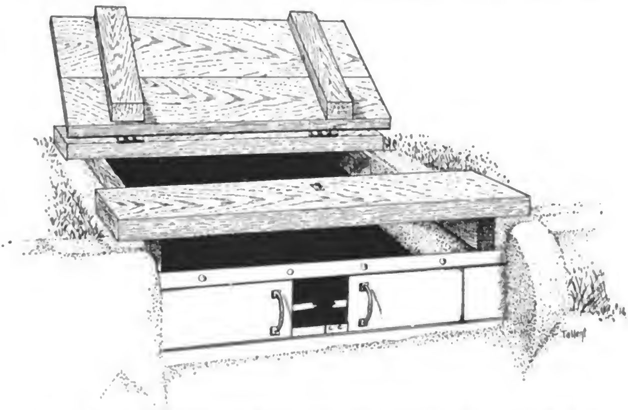

FIG. 2.—Device used by the Riverside Water Company for measuring miner's inches.

inch would be 16¾ cents. Under three of the laterals the water is not charged for on this basis, but a flat rate is made of $12 per acre per year. This plan is followed also in about 12 cases where water is raised from the canal to lands above by means of current wheels or motors, and also in some cases where facilities for measuring water are lacking.

The irrigators under the system are satisfied generally with the plan of delivery because they can get water as often and in such quantities as they desire, provided it is paid for in advance, and as no schedule of delivery has been adopted they are not compelled either to irrigate at a certain time, regardless of whether or not they wish water, or lose their turn. Some of the users, however,

object to the cost of water, which is said to average about $10 per acre per annum, but these objections are not made to the system of delivery.

The total cost of delivery on the system in 1908 was $6,351, or about 73 cents per acre. The cost consisted of $4,896 for zanjeros, $1,080 for the secretary, and $375 as one-fourth of the salary of the superintendent.

THE SANTA ANA VALLEY IRRIGATION COMPANY.

This is a cooperative company irrigating 17,000 acres of citrus and walnut orchards near Santa Ana from the Santa Ana River and wells. The main canal is 12 miles long, and has a maximum flow of 4,500 inches and an average flow of 1,400 inches. At the end of 12 miles it branches into two main laterals which, with the principal distributaries, aggregate 88 miles in length.

PLAN OF DELIVERY.

Water delivery under this system is under the direct charge of a superintendent, who receives a salary of $125 per month. Under him are five zanjeros, three of whom receive $70 each, one $65, and one $60 per month. A portion of the secretary's time is devoted to keeping the records of delivery.

During winter and spring, when water is plentiful, irrigators are allowed water when and in the quantity desired, as under the Riverside Water Company's system. In the main irrigating season the water is rotated according to rules and regulations of the company, rule No. 2 being as follows:

> Water will be served from the company's gates only; it will be limited at all times to one hour to the share, unless it be running to waste or be otherwise ordered by the board of directors, and will be run in turn of gates, except when running to waste, the right-hand gate being served first, where two come opposite, and the larger streams before the smaller ones.
>
> When the water is running to waste and is therefore on application, the limit is hereby suspended, except in the case where another irrigator needs the same ditch or gate, in which case the limit shall be retained, including only the stock appurtenant to the land irrigated through said ditch or gate, and be enforced from the date of the first of the conflicting applications, on twenty-four hours' notice, until such other irrigator has been served to the amount of his limit.
>
> When water is thus on application, the zanjeros shall serve the irrigators in the order of the application on the company's books, shall cancel every application where the irrigator refuses, after due notice, to take the water when his turn comes, and shall serve no irrigator a second time on the same call while unfilled applications from other irrigators remain on the company's books.

Rule No. 3 provides that water shall be delivered only in definite heads to be measured under 4-inch pressure above the top of the

opening through which it is measured, at rates estimated and fixed from time to time by the board of directors. A full head is 100 inches, measured through an opening 33⅓ inches wide by 3 inches deep. Frequently less than a full head is delivered.

The water is rotated between the two main branches. Four weeks are required to cover the entire irrigated area, the time being divided about equally between the two branches. The date of beginning each run is posted in public places and published in the local newspapers. When water is "on application," that is, ample for all demands, any irrigator may obtain a supply during any or all runs by making application at the office of the company forty-eight hours in advance of delivery and paying for it at that time. When the supply becomes too low to deliver on application, strict rotation is followed, beginning at the upper ends of the laterals. The time the full head, 100 inches per acre, is delivered during periods of rotation varies with the supply available at the source, the minimum being twenty minutes. If a fractional head is used, the time is correspondingly increased. The stream commonly used for citrus orchards is 25 inches. The quantity of water usually available per acre is not enough for citrus orchards but more than enough for walnuts, the latter requiring only two irrigations, one early in the spring and the other early in the fall. This has given rise to the common practice of renting shares of stock. The regulations of the company permit this, with the proviso, however, that such renting shall be in writing and good for only one year, but subject to renewal at the end of the year. The form for making such temporary transfers is very simple, being merely an order on the company to "allow ——— ——— to use —— shares of my water stock."

The zanjeros are supposed to be on their respective beats at 6 a. m., and to report to the office at Orange between 11 and 12 o'clock for orders. They are required to visit every gate taking water at least once each day but are not out at night except in emergencies.

The measuring box is merely a cemented section of the lateral with a measuring board set in. The water is forced into the boxes by stop gates set in the cemented sides (fig. 3). The farm laterals at the points of measurement are uniformly 33⅓ inches wide, and if a full head is desired an opening the full width of the lateral and 3 inches high is used, sufficient water being turned into the box to cause it to stand 4 inches above the top of the opening. If only 50 inches is desired, an opening half the width of the box is used. This opening is at one side of the lateral, however, and gives an uneven contraction. The inch, as measured by these boxes, is not accurate, the contractions are not complete, and it is not the legal miner's inch of the State.

RECORDS, FORMS, AND CHARGES.

As all water delivered by this company is paid for at regular rates, complete records of delivery are necessary. Each zanjero is provided with a field book, ruled in blank, for keeping daily records. In this book are noted (1) the name of each irrigator served; (2) the exact time delivery is begun and ended; (3) the size of head delivered to each, and the ditch and gate from which delivered; (4) the number of hours of day water and the number of hours of night water taken by each; and (5) the charge for the water delivered. This field book is in the form of an ordinary time book, with a line to each name and a column to each day. From these books the zanjeros make up the daily report cards sent to the office. A copy of this daily report card is given here.

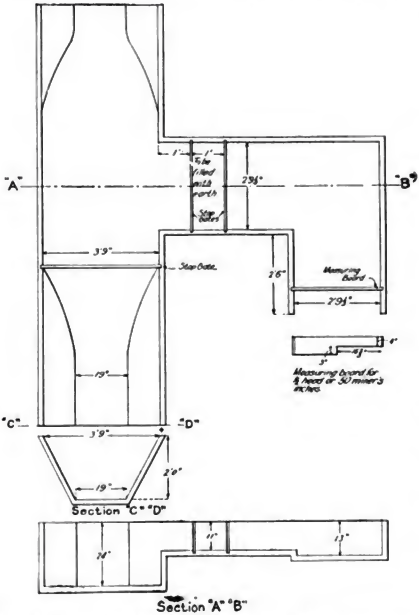

Fig. 3.—Device used by the Santa Ana Valley Irrigation Company for measuring miner's inches.

Form of daily report card used by the Santa Ana Valley Irrigation Company.

DAILY REPORT CARD. SANTA ANA VALLEY IRRIGATION COMPANY.

I certify that I have delivered water to-day as reported below:

No. ----
------ 190--
------ ------, Zanjero.

Name	Head	Ditch	Gate	Started a. m.	Started p. m.	Stopped a. m.	Stopped p. m.	Shortage.	Hours. Day.	Hours. Night.	L. F.	Amount.
....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....

When an irrigator applies for water at the office of the company he brings a small book, similar to a bank passbook, in which the secretary enters the amount of payment and the time water is wanted. An entry of the payment is also made in a loose-leaf ledger, and the charge is later entered from the daily report of delivery sent in by the zanjero. The passbook and the ledger thus give a complete statement of each transaction. The forms of both the passbook and the ledger are suggestive, and are given below:

Form of passbook used for payments for water delivered by the Santa Ana Valley Irrigation Company.

Date.	To—	Date.	Head.	Day.	Night.	Amount.	Date.	Cash.	Amount.
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....

Form of water ledger used by the Santa Ana Irrigation Company.

Date.	To—	Date.	Head.	Day.	Night.	App. book.	Debit.	Credit.	Balance.
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....

The usual charge for water delivered during the spring and summer is 30 to 40 cents per hour for a full head of 100 inches. In winter the charge is only 20 cents. Different rates have been established for water delivered during the day and that delivered at night, the night rate being 15 cents when the day rate is 30 cents per hour. The by-laws provide that from March 1 to September 30 day hours shall extend from 5 a. m. to 7 p. m. and from October 1 to February 28 from 6 a. m. to 6 p. m. When the supply falls the head usually remains the same, but the length of time is reduced, sometimes to twenty minutes.

The charges for quantities over one-tenth of a full head are on the regular basis rate; for one-twentieth of a full head the rate is increased 50 per cent, and for one-hundredth of a head it is increased to four times the basis rate, etc. Other rates for domestic and stock purposes and for sprinkling and spraying, where water is taken in any other manner than from the regularly measured streams, are as follows: Twenty-five cents per month for each family; 25 cents for filling each cistern or storage tank; 10 cents for each sprinkling or spraying tank; 5 cents per month per head for horses, mules, and cattle; and 2.5 cents per month per head for sheep and hogs. The

minimum charge for turning water is 25 cents. Delivery under these rates must be reported by the zanjeros at the beginning of each month for the ensuing month.

THE REDLANDS WATER COMPANY.

This company supplies water to about 1,400 acres of citrus orchards in the immediate vicinity of Redlands, the supply being received from several sources. The main distributary is a pipe line about 8 miles long with 4 or 5 miles of main distributing laterals. During the principal irrigating season—May 1 to October 31—the flow in the main pipe line averages about 300 inches and is quite regular; in winter it fluctuates according to the local demand. About 180 irrigators are served under the system.

The entire work of delivery is attended to by one zanjero, working under a superintendent having general oversight of both delivery and maintenance. The zanjero goes once and sometimes twice daily to all points on the system where water is being delivered. The company has issued 1,500 shares of stock and water is prorated among the owners of these shares, the usual irrigating stream being 25 inches. A definite schedule, giving each irrigator water once every thirty days and showing the time he is to receive it for every run during the season, is arranged at the beginning of each season. There are no departures from this schedule; if a user fails to take water in his regular turn he has no further chance until the next run. The basis of delivery is the 24-hour inch, and no stream is delivered for a period less than twenty-four hours. The number of 24-hour inches delivered per share varies as the season seems to require; in a recent season five 24-hour inches were delivered per share during the first run in May and six 24-hour inches at each of the five subsequent runs, making a total of thirty-five 24-hour inches per share for the season.

The distributing system and measuring devices of this company have been worked out with a good deal of detail and care. All of the pipe lines are of vitrified clay and range from 16 to 5 inches in diameter. At the lower end of the Bear Valley canal one 42-inch and one 48-inch Cipolletti weir are installed to measure the flow into the Redlands reservoir, which is cement lined and has a capacity of 3,000,000 gallons. This reservoir is one of the important features in the distributing system, as it equalizes fluctuations in the supply and provides a steady flow into the pipe lines leading to the farms. Water leaves this reservoir through two 8-inch pipes, which empty into a large box out of which a 12-inch pipe leads to a smaller box where a 49-inch rectangular weir is installed. This weir is not in use at present, and the water is measured over a 100-inch rectangular

weir at box No. 1, a short distance below. The boxes are connected by two 16-inch pipes. There are two pipes, a 16-inch and a 12-inch, leading from box No. 1 to three 30-inch rectangular weirs at distributing box No. 2. The pipes from these weirs are so arranged that some water is diverted to the Center street box and some to the high-school line at box No. 4. At box No. 5, on the Center street line, there are three 30-inch rectangular weirs from which the water is measured into the laterals. At the head of each main lateral and at the highest point on each 10-acre tract the water passes over a 15-inch rectangular weir. There are two 20-inch and one 30-inch rectangular weirs in box No. 2 on the high-school line over which the water passes to the main laterals and farms. In addition to the delivery system as described above, water is received from the Bear Valley Canal at five points above the Redlands reservoir and also from the Bear Valley Irrigation Company's measuring box at Cajon street, known as Big Box. At the weirs over which water passes into the Redlands reservoir a Watson register is installed, and the record sheets are preserved in the office of the company. This register has not been in use for the past three years, owing to the ample supply of water, but it is intended to use it hereafter. No records have been kept of the water received from the various sources, but the company believes that such records would be very valuable. The Bear Valley Irrigation Company keeps a record of the amount it turns to the Redlands Water Company.[a] In addition to this record the zanjero keeps a record of all deliveries to users in an ordinary time book, simply to show that water has been delivered in accordance with the seasonal delivery schedule.

The total cost of water delivery under the system is given as $1,810 per year, or about $1.30 per acre. The żanjero receives a salary of $80 per month, and the superintendent, who has general oversight of both maintenance and delivery, receives $50 per month. The remainder goes for office expenses and for having water turned to the company from the Bear Valley Canal.

THE CRAFTON WATER COMPANY.

This company supplies 1,700 acres of citrus orchards in the vicinity of Redlands. The distributing system is composed of 1 mile of open ditch, 2 miles of main vitrified pipe line, and 2 miles of distributing pipe lines. It has a maximum flow of 1,700 miner's inches and an average flow all summer of 500 miner's inches. There are 80 irrigators under the system, and 18 to 20 are supplied with water each

[a] Since this report was written the Bear Valley Irrigation Company has been made a part of a mutual company, and is owned and operated by the irrigators.

day. The owner of each acre irrigated holds 1⅝ shares of stock in the company and the total supply carried is divided among the users proportionally to the number of shares held.

The force employed in water delivery consists of a zanjero, who distributes the water and maintains the pipe lines, with such additional help as he needs at the time of cleaning and making repairs. The zanjero's time is devoted to making deliveries from 7 o'clock in the morning until noon of each day, and in doing this work he covers about 25 miles. He returns home at noon and at 3 p. m. he again goes over the system to check up his deliveries. He makes no changes on the afternoon trip, all streams running for periods of twenty-four hours or multiples of twenty-four hours. He is directly under the general manager, who maintains only a general oversight of the system and receives but $20 per month.

The size of stream delivered to irrigators varies with the supply. At the beginning of the season the supply available for the next thirty-five days is estimated as nearly as possible, being usually about seven 24-hour inches per acre. A new schedule is arranged for each subsequent irrigation to conform to the available supply. The schedule of rotation is not arranged in accordance with the location of the holdings, but in the order in which the applications were made at the beginning of the season. Most of the users take 15 to 40 inches as an irrigating head. The exact size is decided by the user, but the length of time the stream is run depends upon its size and the number of shares held by the user. The average stream delivered early in the season is about 25 inches, but by the end of the season it falls usually to about 15 inches. The water from the various sources before being distributed passes into a reservoir large enough to hold a flow of 2,000 miner's inches, or 40 cubic feet, per second for twenty-four hours. By keeping a depth of 10 feet of water in the reservoir the zanjero is able to eliminate all fluctuations in the supply and to keep an ample head at the hydrants, of which there is one at the highest point on each 10-acre tract. The distributing pipes leading to these hydrants are of cement and 6 to 12 inches in diameter, and are owned by the company.

A complete system of water measurements has been provided on this system. There is a 54-inch rectangular weir with a water register at the head of the ditch from Mill Creek, and a second weir and register at what is known as Green Spot pipe line, where water is received from the Bear Valley Water Company. At the outlet of the reservoir there is a 100-inch rectangular weir, but no register. Rectangular weirs, mostly with 30-inch crests, are placed at the heads of the laterals leading from the main ditch, a 15-inch rectangular weir at the hydrants on the 10-acre tract, and a 48-inch rectangular weir and register at the end of the main pipe where water is run to

the Redlands Heights pipe line. With these registers the company is able to keep an exact account of all water entering and leaving the system other than that delivered to irrigators. The record sheets are kept by the president of the company as permanent records. The zanjero makes daily check readings from May 1 to October 31 at Mill Creek and Green Spot and at the outlet from the reservoir. He also makes notes in a small book of all deliveries to irrigators, but this record is not turned in to the office of the company.

The total annual cost of water delivery under this system is given as $1,500, or about 90 cents per acre. The salary of the zanjero is $1,020 per year and of the general manager $240 per year, the remainder being for incidental office expenses.

THE LUGONIA WATER COMPANY.

The Lugonia Water Company receives water from the Santa Ana River and the Bear Valley system and irrigates 3,360 acres of citrus orchards at Redlands. Water is delivered through 11 miles of main pipe and 4 or 5 miles of laterals composed of vitrified pipe from 14 to 16 inches in diameter. There is a regular flow of 466 inches available from May 1 to October 31; during the winter months the average drops to 300 inches. One hundred and forty-eight irrigators are served.

Water delivery is attended to entirely by one zanjero. The 466 inches available during the main irrigating season is divided into two equal streams and but two irrigators are served at a time, each receiving the stream of 233 inches per share for twelve minutes, or two hours for 10 shares, the usual number of shares held. A schedule of delivery is prepared at the beginning of each irrigating season and the intervals fixed at thirty days. The custom is, however, to receive a half supply every fifteen days rather than a full supply every thirty days. Some irrigators still prefer to water their entire acreage at one time and this is arranged for through neighboring farmers pooling their interest, one receiving the entire 233 inches at one run and the other receiving it at the run fifteen days later.

All of the water received and delivered is measured over rectangular weirs. Besides the one at Sunnyside divide, where the supply is received from the Bear Valley system, there is a 40-inch weir at the head of each main lateral and at the point of delivery on each 10-acre tract. The simple plan of delivery makes records unnecessary. The supply not only is maintained at a stated amount throughout the year—466 inches from May 1 to October 31 and 300 inches from November 1 to April 30—but the season's schedule is adhered to strictly except when neighboring irrigators pool to take water every thirty days instead of every fifteen days. While this simple plan is

in the main very satisfactory, some of the irrigators feel the need of a reservoir to store the water not really needed, as at present it must be used at a stated time or not at all, but if storage were possible smaller heads for a longer time could be permitted in certain cases.

The total annual cost of delivery is approximately $1,500, of which $1,200 is the salary of the zanjero and $225 the salary of the secretary. The cost per acre is about 45 cents.

THE SAN ANTONIO WATER COMPANY.

The San Antonio Water Company receives water from San Antonio Creek, two tunnels, and wells, and supplies 6,000 acres of citrus orchards in the vicinity of Ontario. Water is delivered through cement pipes, there being a main pipe about 15 miles long and 100 miles of 8-inch and 10-inch lateral pipes. The ownership of the system is divided into 6,000 shares and each shareholder receives his pro-rata share of the total supply available on the basis of the number of shares held. There are 600 irrigators under the system, the largest number of shares held by any one being 72, the smallest one-fifth share, and the usual number 5 to 10.

The general manager of the company is responsible for the delivery of water to irrigators, but the work is performed by a chief zanjero at $100 per month and one assistant zanjero at $75 per month. The company has a superintendent, but he has charge only of construction and maintenance. Both the chief zanjero and his assistant are furnished with motor cycles by the company. The chief zanjero prepares a rotation schedule for the entire season. Rotation is begun at the head of the laterals and is repeated at intervals of one month. The heads vary from 35 to 60 miner's inches, the average being about 45, and are run to the holder of each ten shares for twenty-four hours at each run. An average of one share is held for each acre irrigated, although some irrigators use as much as 1½ shares per acre. The two zanjeros together handle 20 heads at one time, the heads being kept uniform throughout each rotation. Although the water users know after the first run the hour and day they will receive water each month the chief zanjero gives them notice two days in advance in order that no water may be wasted by the user having forgotten to take it. If an irrigator does not want water when his turn arrives, he is passed until the next regular run.

Water is measured over galvanized-iron rectangular weirs 28 inches long set in cement inside of measuring boxes. These boxes are 4 feet square outside and made of cement or brick covered with cement, with walls 4 inches thick and a partition of the same material 12 inches from one side. They are 6 feet deep, stand 18 inches above the ground, and have galvanized-iron weirs set in the partitions.

The water from the main pipe line enters the smaller chamber made by the partition, is forced up and over the weir, falls into the larger chamber, and passes out through a 4-inch by 8-inch opening in a sheet of galvanized iron into the cement pipe line leading to the orchard. This opening is provided with a sliding plate used to regulate the length of the opening. Below the 28-inch weir there is an iron gate through which water is run when no deliveries are being made. The boxes are covered with boards and a hinged door provided with a lock. They are not always kept locked, however, and the gates are usually set by the irrigators with the permission of the zanjeros. Aside from the record of the total supply of water available, no records of delivery are kept, unless through some accident the schedule must be altered, in which case a note is taken of it by the zanjero and the record thus kept complete.

The total annual cost of water delivery under this system is given as $2,220, or 37 cents per acre. Of this amount, $2,100 is for salaries of the zanjeros and the remaining $120 for office expenses.

THE COVINA IRRIGATING COMPANY.

This company controls a small system at Covina, watering 4,500 acres of citrus orchards. The water supply is derived from the San Gabriel River and from a number of wells feeding four pumping plants. The distributing system is composed of 6 miles of mains, partly cemented ditch and partly cement pipe, and 30 miles of cement-pipe laterals. The maximum stream carried is 40 cubic feet per second, and the average about 12 cubic feet per second. The water of the system is prorated among the irrigators in accordance with the number of shares held by each, three being the usual number held per acre irrigated. The usual stream delivered is 25 miner's inches, although in some cases as much as 100 miner's inches is delivered.

Water delivery under the system is nominally in charge of the superintendent. The work, however, is left entirely to two zanjeros, the chief zanjero receiving $85 per month for eight months and $75 per month for four months, and his assistant receiving $75 and $70 per month, respectively, for the same periods. Delivery is begun at the lower end of the laterals and the apportionment is made on a basis of 25 inches for twenty-four hours for each 10 shares held. The stream delivered is uniform throughout the season, but the number of hours varies according to the supply, being lengthened usually to forty-eight hours in the fall. The zanjeros are required to give users forty-eight hours' notice of the exact time water will be turned to them. This notice was given formerly on printed forms, but now verbal notice in person or by telephone has been substituted.

The size of stream for each 10 shares held is kept constant throughout any one season by means of an equalizing reservoir holding a

flow of 100 miner's inches, running for eleven days. If the river supply fluctuates, the zanjeros use this basin either as a supplemental supply to make up any deficiency or as a place to save any excess.

The weirs formerly used for measuring the water have been replaced by cement miner's inch boxes, 26 inches wide, 30 inches long, and 6 feet deep (fig. 4). The water enters through a cement pipe at the bottom of one end of the box and passes out through two openings on one side near the top. At the end opposite the point of entrance there is a waste way with two openings, each having a galvanized-iron crest 4 inches above the center of the openings in the side, which take care of minor fluctuations in the head. Directly below the waste way at the bottom of the box is the main waste way, regulated by an iron gate, which keeps a constant head of 4 inches above the center of the openings in the side. These openings are each 4 inches high and 12.5 inches wide, have galvanized-iron crests, and are closed when not in use with galvanized-iron gates. Many of the measuring boxes are provided with a series of discharge openings of different lengths, so as to deliver heads of different sizes, such as 10, 25, 50, and 100 inches, or a combination of two or three of these.

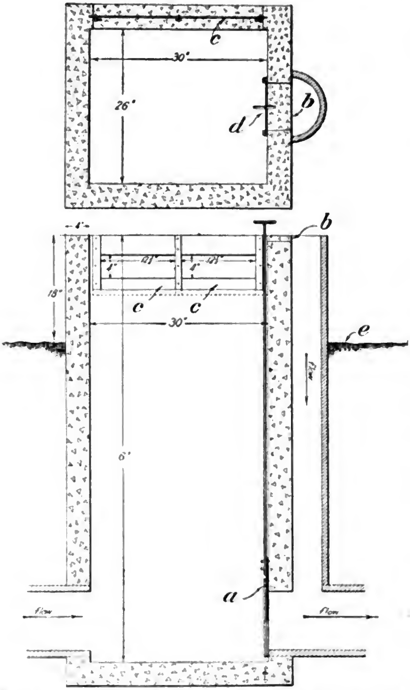

FIG. 4.—Device used by Covina Irrigating Company for measuring miner's inches: *a*, main waste way; *b*, overflow waste way; *c*, miner's inch openings; *d*, galvanized-iron crest of overflow waste way; *e*, level of the ground.

The two zanjeros make daily reports on the form shown below to the secretary of the company, showing the amount of water delivered to each user during the day, these reports being the basis of the water

charges. Water costs the irrigator at the rate of $2.50 for 100 miner's inches for each twelve hours.

Form of zanjero's daily report, used by the Covina Irrigating Company.

ZANJERO'S DAILY REPORT TO SECRETARY COVINA IRRIGATING COMPANY.

Date......, 190..	Number of lateral.	Number of hours stock and alien.	Number of hours contract.	No. inches.		Amount.	
				Day.	Night.	Dollars.	Cents.
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....

The total cost of water delivery under the system is given as $2,750 per year, or 60 cents per acre. Of this, $1,860 are paid in salaries to the two zanjeros, $800 being used as the salary of the secretary and for other office expenses. The superintendent, whose duties are almost wholly with maintenance, received $75 per month, but only $90 of his yearly salary is charged against water delivery in the above estimate.

THE AZUSA IRRIGATING COMPANY.

The Azusa Irrigating Company controls a small system at Azusa, which waters 4,043 acres of citrus orchards. The main distributary is a cement-lined ditch 3 miles long, with 3 miles of 36-inch to 14-inch cement-pipe mains and 35 miles of 8-inch and 10-inch cement-pipe laterals. The water supply of the system comes from San Gabriel River. The maximum flow carried in the main canal is 28 cubic feet per second and the average 12 cubic feet per second.

The president of the company has general oversight of water delivery, but devotes practically no time to the work. The detail of delivery is in charge of a zanjero, who is paid $100 per month for eight months and $60 per month for the remaining four months. Under the zanjero is a superintendent, whose duties are in connection with the maintenance of the system, although he sometimes assists the zanjero in water delivery. The secretary of the company devotes nearly all of his time to the bookkeeping and receives a salary of $50 per month.

Water is delivered to the 250 irrigators of the system in rotation, beginning at the heads of the laterals. The minimum stream delivered is 25 miner's inches, the maximum, 100 miner's inches, and the usual stream, 35 miner's inches. The usual size of holdings is 10 acres, and for such a holding it is customary to deliver 35 inches for twenty-four hours every thirty days, except in the case of small fruits, when delivery is made every ten or fifteen days. Users are permitted to receive any size of head within the minimum and maxi-

mum limits mentioned, but the time they may receive such head varies so that the total supply delivered may be kept within the amount due. The zanjero is required to give the users a verbal notice forty-eight hours in advance of delivery. As the supply in the system and the size of heads delivered to users vary, each schedule is arranged independently of the others to conform to the supply available from the river.

A miner's inch under 4-inch pressure is the unit of delivery. The measuring box is practically the same as that of the Covina Irrigating Company, the main difference being that the gate or orifice is of cast iron instead of galvanized iron. All of the measuring boxes are provided with locks, and no stockholder is allowed to raise any gate or divert any water without the consent of the zanjero, under penalty of a fine not to exceed $25 for each offense and having his supply of water shut off until such fine is paid. Only the owners of land inside of the Azusa water district are allowed to hold stock in the company, and no one is permitted to subscribe for less than three shares per acre.

The zanjeros forward daily reports to the secretary showing the water delivered, and from these reports the latter makes up the water charges. The report blanks are large enough to take a record of at least 12 deliveries.

Form of zanjero's daily report used by the Azusa Irrigating Company.

AZUSA IRRIGATING COMPANY.

Zanjero's Daily Report.

———, 190—.

Run to—	Inches.		From—	To—	Number of hours.	Amount.		
	Day.	Night.						
			a. m. p. m. a. m.	a. m. p. m. a. m.				

——— ———, *Zanjero.*

The basis of water charges is a stream of 100 miner's inches running for twelve hours, the average price of such an amount being $3, the minimum $1.20, and the maximum $5.40, charged during July, August, and September. Night rates are but one-half day rates. The average charge per acre per year is about $10. Statements of account are sent out by the secretary on the first of each month, and a discount of 10 per cent is allowed for payment prior to the fifteenth.

The total cost of water delivery under this system is given as $1,940, or about 48 cents per acre. Of this, $1,040 is paid to the

zanjero, $600 to the secretary for the work in connection with water charges, and $300 is for general office expenses.

THE MODESTO IRRIGATION DISTRICT.

About fifty irrigation districts were organized in California under the Wright irrigation district act of 1887, only a very few of which have been successful, the most prominent of these being the Modesto and the Turlock districts. These were two of the first districts organized, the author of the district law being a resident of the section included within the Modesto district. As finally organized the two districts comprise about 250,000 acres. The land was once a vast grain field, but is now being broken up rapidly into farms of 20, 40, and 80 acres. Every acre of land within the districts on which water can be run, whether town or farm property, is taxed to support the districts regardless of the quantity of water used. The two districts have practically the same requirements in connection with water delivery and practically the same obstacles to overcome. Therefore, what is said of the Modesto district is in general true of the Turlock district.

The total length of the Modesto Canal is 45 miles, and leading from it are eight laterals aggregating 81 miles in length. The main canal and these laterals cover 81,143 acres. The maximum flow in the main canal as constructed at present is 580 cubic feet per second, and in 1908 only 20,000 acres, or about one-fourth of the total area within the district was irrigated.[a] The district has been conceded a right to a continuous flow of 850 cubic feet per second at La Grange, and before many years the canal will be increased to that capacity. Alfalfa is the principal crop grown, but the areas devoted to orchards and vineyards have been greatly increased during the past few years.

The districts are operated under the Wright law, as amended in 1897, which has the following provision regarding the distribution of water:

> It is hereby expressly provided that all waters distributed for irrigation purposes shall be apportioned ratably to each landowner upon the basis of the ratio

---

[a] The area irrigated in 1910 was 28,195 acres, but the amount of water run was no greater than in 1908.

Since 1908 the superintendent of Modesto district has made a number of changes in the plan of water delivery. He now distributes water to each of the eight main laterals in strict accordance with the area irrigated under each lateral, unless water is not needed. Another change is in the matter of records. Formerly receipts were taken from each irrigator for water delivery. These are no longer taken, but each ditch tender telephones to the office at Modesto daily reports of all deliveries, stating the irrigators being served, time service begins and ends, and crop irrigated. These reports are entered on cards and form a complete record of water delivery.

which the last assessment of such owner for district purposes within said district bears to the whole sum assessed upon the district: *Provided*, That any landowner may assign the right to the whole or any portion of the waters so apportioned to him.

This provision apparently gives a definite basis for water distribution within irrigation districts in California, but as a matter of fact no attention whatever is paid to it in the Modesto district, and it would be very difficult to do so. The law provides that landowners shall receive water in proportion to their district assessments, and that they shall have the right to assign their shares. The landowners include those who own town property within the districts, and the ownership of a business corner in Modesto carries with it a right to its pro rata of the entire water supply of the districts. A business corner has no need for irrigation, and in practice water is apportioned on the basis of the number of acres irrigated, no attention being paid to the assessments. As pointed out in a bulletin of this Office,[a] if the law and the present practice are not made to conform by changing one or the other, considerable confusion will arise when the owners of the non-irrigable but highly assessed property demand the water due them under the law, and the water becomes a subject for barter and sale—a condition which the very principle of district organization seeks to eliminate.

RULES AND REGULATIONS GOVERNING WATER DELIVERY.

The board of directors of the Modesto district has adopted a number of rules and regulations to govern water distribution, of which the following are a part:

(1) Between January 1 and March 1 of each year the ditch tender shall obtain from each user of water a written application, on blanks furnished by the district, specifying the number of acres he expects to irrigate, the kinds of crops, and the number and size of his diverting weirs, and upon such application it shall be the duty of the ditch tender to certify whether or not the applicant's weirs and ditches are in proper condition. * * * These applications, together with such certificate, shall be filed with the superintendent in the office of the district, and no water shall be furnished to any applicant until such application and certificate shall have been properly executed and filed.

(2) Each irrigator will be allowed not to exceed one hour[b] to irrigate an acre of land in alfalfa and other crops or land requiring flooding, but for trees, vines, and gardens the district will endeavor to supply a continuous flow, and in case of a scarcity of water, to provide rotation as often as possible; the time will start upon delivery of water to irrigator, and water must be used night or day continuously until time limit expires.

(3) Each irrigator shall be notified by the ditch tender at least twenty-four hours before the water will be delivered to him, and further notified of any

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 158, pt. 3.

[b] This time has since been changed to one-half hour and to twenty minutes in times of extreme low water.

change in the time of delivery, and the irrigator who has failed through any fault of his own to use water during an irrigation will not be entitled to any more water at any future irrigation than if he had used his full share at the time of allotment.

(4) The water shall be furnished in rotation to each irrigator (except by agreement between adjoining owners, satisfactory to the ditch tender, and which will not change the time of irrigation to other irrigators), commencing at the lower end of each lateral or distributing ditch. When a break occurs in any of the ditches, the party to whom the water is given until such break is repaired shall be allowed to finish before the water is taken from him, and shall not claim another irrigation for that run. When the ditch is repaired, the party using water at time of break shall have water returned to him to finish.

(5) Any person to whom water is offered from any ditch during the season must sign a receipt therefor. If the water is used, the receipt must show upon what kind of crop it was used; and if it is not used, the receipt must specify the reason. The object is to show the number of times water can be used should persons so desire, and also that it is not the fault of the district's officers that some people do not receive the water as often as others.

(6) The water will be apportioned to each lateral by the superintendent, and the ditch tenders will be in charge of the distribution of the same and will be held directly responsible by the superintendent.

(8) The district's employees alone will be allowed to open the discharge gates, and they have full authority to close the same as soon as the requisite amount of water for each irrigation has been discharged. Said gates will be supplied with locks, and the keys shall all be under control of the superintendent.

(11) Before water is furnished to any private distributing ditch the landowners receiving water therefrom must agree upon and sign rules and regulations satisfactory to the board of directors, providing for the repair, maintenance, and distibution of water from such ditch, authorizing some one of the signers to represent the users in all conferences with the ditch tender, and providing for the apportionment of the water, and that it shall be used in rotation, commencing at the lower end of such ditch and subject to all other rules and regulations of the district.

(15) Each ditch tender shall have full charge of his respective section and shall be responsible therefor. From his rulings and actions an appeal may be made to the superintendent, which may be filed in writing with the secretary for him. From the action of the superintendent appeal may be made to the board of directors by anyone who considers himself aggrieved.

Perhaps the most noteworthy of the above rules is No. 15. This is the only instance encountered in which a canal superintendent is not directly responsible for water delivery. During the past season the superintendent has questioned the advisability of retaining this rule, and has recommended that he be made responsible in theory as well as in fact, as he is required by circumstances to direct delivery personally, in large measure.[a] The applications as provided for in rule No. 1 are taken on forms bound in small books convenient for the ditch tenders in taking and for the office in filing. The head allowed

[a] Since this was written the rules have been changed to give the superintendent complete control of water distribution and delivery.

in practice under rule 2 is 10 to 20 cubic feet per second for alfalfa and 0.5 to 1 cubic foot per second for orchards and vineyards. The custom has been to run a continuous stream for orchards, vineyards, and gardens, but the superintendent aims to put all crops on an "alfalfa" basis; that is, to deliver to all crops on a time basis, with the number of hours per acre varying with the needs of the different crops. Rule 4 was intended, doubtless, to insure the lower irrigator as good service as the irrigator above. It met with the practical difficulty, however, that the water not taken by the lower user for any reason was wasted, and the superintendent had to reverse the practice. Delivery now begins at the heads of the laterals. The receipts provided for in rule 5 are taken in duplicate, the stubs being retained by the ditch tenders and the originals forwarded to the office at Modesto. Their value has been considerably lessened, as no satisfactory way has been found for filing them. No records of delivery are kept, and under the system there is no way of getting any complete records of delivery, such as are considered so valuable on many systems.

The main laterals are so arranged that at present most irrigators receive water directly from them in their own private ditches. A number of colony tracts, divided into small holdings, have been opened, however, and these require a large single lateral leading from a main district lateral to supply them. It is for delivery on such laterals that rule No. 11 provides. The independent delivery contemplated by the rule for these laterals has not proved satisfactory, the irrigators seeming to prefer delivery by the district ditch tender rather than by one of their own appointment. Consequently, the district has recently begun to take over these laterals and manage them exactly as its own main laterals.

Following out the apparent intent of rule No. 15, each ditch tender follows his own notion, resulting in numerous plans. One aims to deliver water from any section of his lateral practically on demand, so long as a user receives no more of his share; another delivers in runs, supplying water to one user after another, beginning at the upper end of his lateral, insisting that each user take water in his turn or not at all; and a third delivers in runs, but is less particular about a strict enforcement of turns, allowing a user to make up in one run what he did not care to take during a preceding run.[a]

MEASUREMENTS AND EXPENSES.

No measurements are now made at any point in the district except at the head of the canal at La Grange. There frequent current-meter ratings are made and daily gage readings are taken and telephoned

[a] Since this was written the plan of delivery in strict rotation on all the laterals has been adopted.

to the office at Modesto. When there is a flow of more than 300 cubic feet per second in the canal the superintendent keeps water flowing continuously in all of the laterals, the amounts in each carrying from 20 to 200 cubic feet per second in the main laterals and 10 to 25 cubic feet per second in the private laterals supplying communities of irrigators. When the supply falls below 300 cubic feet per second it is " bunched " and run in only two or three laterals at a time and in strict rotation.

This district is well covered by telephone lines, there being an aggregate of 110 miles already constructed. Of the total, the district owns a 35-mile line from Modesto to La Grange, and has subsidized farmers' lines, aggregating 75 miles in length, at $15 to $75 per line, having paid $490 in subsidies, which are given in consideration of the free use of the lines by the district officers and employees, without any obligation on the part of the district to pay any of the cost of maintenance. Additional farmers' lines will be subsidized until the entire district is covered. The cost to the district for construction and maintenance of the 35-mile line to La Grange averaged about $100 per mile.

The cost of water delivery for 1907 is given by the secretary of the district as approximately $8,000, or about 40 cents per acre for the 20,000 acres irrigated. This included the salary of the engineer and superintendent for eight months at $125 per month, the salaries of the 15 ditch tenders for the same period, and the printing of receipt and application forms. Nothing was included for the secretary, as the time devoted by him to delivery balanced the time spent by the superintendent in maintenance. The ditch tenders start at $60 per month each, and are increased to $65 the second year, $70 the third and fourth years, and $75 after they have begun the fifth year of service. The district furnishes no conveyances, and where a horse is furnished, $5 per month is deducted from the salary. In 1904 $50 per month was paid, with $10 per month added when a conveyance was needed.

SYSTEMS USED ON TYPICAL CANALS IN COLORADO.

THE NORTH POUDRE CANAL.

This canal system is composed of the North Poudre Canal and 20 reservoirs and covers a large tract of land north of Fort Collins, Colo. It is controlled by the North Poudre Irrigation Company and the water supply is derived from Cache la Poudre River and Box Elder, Coal, and Park creeks. The main North Poudre Canal in 25 miles long and leading from it are 140 miles of main laterals. The total acreage irrigated is 27,500, of which 7,000 was in alfalfa in 1908, 18,000 in grain, and 2,500 acres in sugar beets. The maximum flow in the main canal is 210 cubic feet per second. A large part of the

supply is stored in the reservoirs during periods of high water and later either run from the reservoirs into the company's ditches or exchanged with other systems for water directly from the river. There are 500 stockholders in the company and approximately the same number of irrigators. The land under the system was sold to the irrigators with 25 shares of stock in the company for each 80 acres, there being 8,000 shares and 320 80-acre rights.

PLAN OF DELIVERY.

Water delivery is in charge of a superintendent with headquarters at Wellington, near the center of the system. In 1908 seven canal riders were employed. The period of service of the canal riders is limited to the irrigation season, April to September, but they are employed subsequent seasons if they have proved satisfactory. Each canal rider is provided with a horse and cart, and covers 25 to 30 miles of ditch each day.

Water is kept in the canals constantly during the irrigation season and is delivered to the irrigators practically on demand. At the beginning of each season the superintendent estimates the total supply likely to be available, being careful to make his estimate conservative, and determines the quantity that can be delivered for each share in the company. This is comparatively easy, as the greater part of the water is stored in the reservoirs, which have been surveyed to show the capacities at various depths. In years of normal stream flow the apportionment per share is about 200,000 cubic feet, or about 4.6 acre-feet. In 1908 the apportionment was only one-half of this amount. The canal rider is provided with a complete list of the shareholders on his division, showing which, if any, are delinquent in assessments, as such delinquents are not allowed to receive water. When a shareholder wishes water he notifies the superintendent, who instructs the canal riders to make the deliveries ordered. No stated size of stream is adhered to, it being the policy of the management to give as large a head as the available supply and the number of irrigators from one lateral will permit. The system has public telephone connection with nearly every farmhouse.

Water is delivered over rectanglar weirs having crest lengths of 1, 1.5, 2, 3, 4, 5, and 6 feet, depending upon the amount to be run. The discharge over the weirs is regulated by iron headgates, a sketch of which is shown in figure 5. These are set in concrete in the canal bank, fastened to the upstream ends of the tile-pipe outlets, and arranged so that they can be locked readily either to prevent any change or to permit it only within certain limits. These gates are supplied f. o. b. Fort Collins, at $14 to $38, to fit tile from 6 to 24 inches in diameter.

RECORDS, FORMS, AND EXPENSES.

Each canal rider is provided with a table of discharges over standard rectangular weirs, with two complete end contractions, and a table of corrections to be made where there are no end contractions. The weir tables show the discharge in cubic feet per second, Colorado statute inches, cubic feet per hour, and cubic feet per twenty-four hours. The unit used is the usual Colorado inch, of which 38.4 are equal to 1 cubic foot per second, while the flow in the main canal and laterals is usually reckoned in cubic feet per second. These detailed tables enable the canal riders to make accurate deliveries with little difficulty. Each rider is provided with a record book in which a complete record of deliveries is kept. This book provides

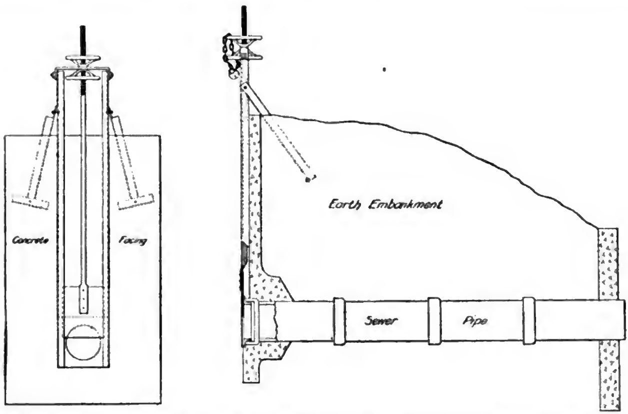

FIG. 5.—Iron gates used at heads of laterals by the North Poudre Irrigation Company.

one page for each irrigator and shows the number and size of weir over which water has been delivered, the date of delivery, depth over the crest of the weir, discharge in cubic feet per second, hours run, and the total number of cubic feet run. A space is provided to show the total amount in cubic feet per second of water delivered to the irrigator up to the end of delivery. This book contains also a table of equivalents of the standard units of measurement by means of which the rider can readily convert one unit into another. The riders send to the superintendent each day written reports from this book, showing the amount of water run to each user. The following is a copy of the report of one canal rider for one day, and of a page in the field book, showing the form and value of these reports.

Copy of daily report of canal rider of the North Poudre Irrigation Company.

Water delivered by the North Poudre Irrigation Company June 20, 1907.

To—	Over weir No.	Size weir.	Depth.	Hours run.	Amount.	Remarks.
			Inches.		*Cubic feet.*	
J. D. Dunbauld	....	24	5	24	147,880	(Here is given description of holdings.)
W. A. Richard	....	24	4¾	24	138,552	
J. T. Wright	....	24	5½	24	170,371	
Z. Hughes	....	24	4¾	24	138,552	
G. C. Ritter	....	24	5½	9	63,882	
George Palmer	....	24	4¾	24	138,552	
G. S. Pintler	....	24	5½	24	170,371	
W. L. Sivers	....	24	5¼	24	160,056	
George O. Dodge	....	24	4½	24	127,180	
L. Francis	....	24	5¼	24	160,056	
R. L. Shrader, rate box.	....	....	[a] 1.3	24	120,960	

[a] Feet.

Measured by I. G. GOODING, *Canal Rider.*

Sample page from field book of canal rider of the North Poudre Irrigation Company.

WATER DELIVERED BY THE NORTH POUDRE IRRIGATION COMPANY.

To Edson Waddle.
No. of weir 40 Size weir 24 Rate box ______.

Date.	Depth.	Cubic feet per hour.	Hours run.	Amount.	Remarks.
June 24	3	2,921	5	14,610	
June 25	4	4,460	24	107,056	
June 26	4	4,460	24	107,056	Part of east ½ of 29-9-68.
June 27	4	4,460	24	107,056	
June 28	4	4,460	24	107,056	

Total to June 28, 1908=442,834 cubic feet.
Posted on page 67.

In addition to the record books and the daily reports of delivery just described, a complete ledger is kept in the superintendent's office showing the delivery to each irrigator throughout the season. The pages in this ledger provide space for each day during the months of April to September, inclusive, and show for each irrigator and for each run not only the number of the weir, its size, the depth over crest, the hours run and amount run, but also the kind of crop irrigated.

The total cost of water delivery under the system is given as $4,475, or about 16 cents per acre, of which $1,200 is the salary of the superintendent, $3,000 the total salaries of the canal riders, who receive $75 per month each after satisfactory service, and $275 the office expense properly chargeable to delivery.

THE LARIMER COUNTY CANAL.

The Larimer County Canal is controlled by the Water Supply and Storage Company. It has a comparatively late priority on the

water of the Cache la Poudre River and depends on stored water and streams outside of the basin of the Cache la Poudre River. Its present supply comes from Cache la Poudre, Grand, and Laramie rivers, and Michigan Creek, the Grand being on the western slope of the Rockies and Michigan Creek and Laramie River being tributaries to the North Platte. The main canal is 72 miles long and has 78 miles of distributing laterals. The acreage irrigated in 1907 was 36,700, consisting of 1,500 in orchard, 8,000 in alfalfa, 15,000 in grain, 2,700 in sugar beets, 6,800 in potatoes and 2,000 acres in native grasses. The maximum flow in the main channel is 600 cubic feet per second and the average about 250 cubic feet per second. The length of the 23 laterals varies from 0.5 mile to 20 miles. Of the 600 shares of stock 496 have been issued and are held by 270 water users, each holding one-fourth to 24 shares.

PLAN OF DELIVERY.

Water delivery under this system is under the direct control of the president of the company, who acts as superintendent and has six ditch riders under him. The first rider is located at the headgates, about 7 miles above Fort Collins, attends to the headgates, and rides the first 6 miles of the canal; the second and third tend 15 miles of canal each, and the others 12 miles each.

The distribution of water among the ditches in Colorado is under public authority. Each stream usually comprises a water district within which water distribution is controlled by a water commissioner acting under the direction of the division engineer, who in turn is under the state engineer. The water commissioner on the Cache la Poudre River receives telephone messages every evening from observers at Chambers Lake, a large storage reservoir near the summit of the Rocky Mountains owned by the company, and from Grand River Ditch, as to the amount of water the Water Supply and Storage Company is turning into the Cache la Poudre River. On the following day the company is permitted to divert this amount into its canal less an allowance for seepage and evaporation losses, together with any water that may be due directly from Cache la Poudre River on the company's priorities. As soon as the headgate attendant on the Larimer County Canal receives notice from the water commissioner as to the amount of water the canal will be allowed to divert, he notifies the superintendent and the ditch riders,[a]

[a] Outside of Chambers Lake the principal reservoirs of the Water Supply and Storage Company are situated below the inlet of Larimer County Canal and the water stored in them must therefore be used by exchange with canals lower down the river which are entitled to receive water from the river. During times of such exchange the Water Supply and Storage Company must

and this report forms the basis for water delivery on the following day, when the superintendent or the headgate attendant notifies the ditch riders of the amount of water to be delivered for each share of stock and the ditch riders set and lock the gates at the heads of the 148 laterals leading from the main canals in order to give each the share to which it is entitled. On some of the laterals 20 or more farmers receive water from a single headgate, the water being divided usually by a special ditch rider employed by the farmers. If for any reason a farmer does not care for water he informs the ditch rider on the main canal or the lateral.

When a ditch rider on the main canal sets and locks the headgates, he deposits in a metal case hanging on the gate a small card showing the number of shares held by the users, the number of inches allowed for each share during the current day, and the depth over the weir necessary to give that amount. This card remains in the box until replaced by one for the following day, thus enabling any irrigator under the lateral to ascertain at any time if he is receiving his proper allowance. The water is measured to the various laterals over wooden rectangular weirs set short distances below the lateral headgates, and having crest lengths of 1 to 6 feet, depending upon the amount of water to be delivered. The flow is regulated by iron headgates similar to those used on the North Poudre system (fig. 5, p. 39).

Section 8 of the by-laws of the company governing the distribution of water is given in full below. The provisions are general and show merely the powers of the company in reference to distribution and the requirements for receiving water:

Any water supplied by this company, which is delivered or caused to flow into the Larimer County Ditch, either from the reservoirs of this company or from any other sources provided by this company, shall be under the control of this company, subject to any contract to protect the rights of the Larimer County Ditch Company in the control of the canal, and shall be distributed pro rata among the stockholders of this company who shall then own and control water rights in the Larimer County Ditch, who shall from time to time be entitled to the same, or their lessees, agents, or other representatives.

In order for a water-right owner in the Larimer County Ditch Company to be entitled to receive water distributed by this company, he must have stock in this company, with all assessments paid, to the extent of one share of stock for every water right upon which he receives water.

RECORDS AND EXPENSES.

Each ditch rider is provided with a record book, of which sample pages are here shown. Each page provides for the record for two

also await notice from the water commissioner before making diversions on account of the exchanged water. For a full account of the interesting system of exchanges used on Cache la Poudre and Big Thompson rivers, Colorado, see U. S. Dept. Agr., Office Expt. Stas. Buls. 134 and 218.

weeks. At the close of each season these books are filed in the office of the company, and new books are issued at the beginning of the following season:

Sample pages from record book of ditch rider of the Water Supply and Storage Company.

RECORD OF WATER DELIVERED IN FIRST DIVISION OF CANAL OF THE WATER SUPPLY AND STORAGE COMPANY.

Name.	No. of gate.	Size of weir.	Inches per share.	Week ending August 6, 1904. S.	M.	T.	W.	T.	F.	S.	Week ending August 13, 1904. S.	M.	T.	W.	T.	F.	S.
				10.	10	15.	15.	15.	15.	15.	12.	12.	15.	15.	10.	10.	10.
Golding Duyre	3	24	Number of rights.	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼
			Inches in depth.	[illegible]	[illegible]						[illegible]		[illegible]		[illegible]		
Geo. Stanley	7	24	Number of rights.	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Inches in depth.	1 1/16	[illegible]						[illegible]		[illegible]		1 1/16		
Mrs. C. P. Miller	10	24	Number of rights.	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			Inches in depth.	1 1/16	[illegible]												

The ditch riders are also provided with weir tables, showing the depths of water to be run over weirs of the various sizes for each share or fraction thereof of stock in the company. These tables are based on the delivery of 0.667 cubic foot per second per share, which is equivalent to 26 statute inches, or 40 "farmer's" inches, the usual measure in water delivery. No computations are necessary on the part of the ditch riders other than to make proratings when the supply being delivered is below the 40 farmer's inches per right, on which the tables are based. When prorating it is necessary only to multiply the number of inches being given to the right by the number of rights to go through the weir and divide by 40. The quotient is the number of full rights, and from the table the corresponding depth on the weir is found.

A complete record is kept in the office of the company at Fort Collins of the amount of water in each reservoir of the system, the daily withdrawals from each, and the daily flow both in the mountain supply ditches and in the main canal. The measurements in the main canal are made over a weir 2,000 feet below the headgates, where a recording apparatus is kept. Books have been printed especially for these records, each page of which has space for a complete record of the daily operations and conditions at the water source for one month. The following is a copy of a portion of the water-ledger page for July, 1908.

Sample page from water ledger of the Water Supply and Storage Company.

THE WATER SUPPLY AND STORAGE COMPANY.

Record of weir measurements and discharge of ditches and record of water stored in reservoirs during the month of July, 1908.

	Larimer County ditch.				Laramie River Ditch.				Depth in feet.									
Day of month.	Depth in feet. 6 a. m.	12 m.	6 p. m.	Total discharge (cubic feet per second).	Depth in feet. 6 a. m.	12 m.	6 p. m.	Total discharge (cubic feet per second).	Reservoir No. 1.	Reservoir No. 2.	Reservoir No. 3.	Reservoir No. 4.	Reservoir No. 5.	Lindenmeir Lake.	Richards Lake.	Black Hollow Reservoir.	Curtis Lake.	Grand River ditch (cubic feet per second).
1	3.2	3.2	3.2	301	....	2.21	....	115	28-0	2-0	2-0	16-0	27-0	8-0	18-6	23-0	12-6	103.4
2	3.1	3.1	3.1	228	....	2.2	....	114	....	....	....	....	....	....	....	....	2.89	102.72
3	3.1	3.1	3.1	228	....	2.16	....	110	27-4	2-0	2-0	18-4	27-6	8-0	18-2	22-10	12.6	100
4	3.1	3.3	3.3	329	....	2.16	....	110	....	....	....	....	....	....	....	....	....	....
5	3.3	3.3	3.3	329	....	2.19	....	113	....	....	....	....	....	....	....	....	2.92 2.49	104.8 109.7
6	3.4	3.4	3.4	329	....	2.19	....	113	....	....	....	....	....	....	....	....	2.92	104.8
28	2.3	2.3	2.3	179	....	1.7	....	68.5	....	....	....	....	....	....	....	....	1.97	45.96
29	1.6	1.6	1.6	118	....	1.71	....	69.28	....	....	....	....	....	....	....	....	1.92	43.56
30	3.5	4.5	4.5	343 487	....	1.82	....	77.96	29-0	....	....	15-0	29-0	8-6	18-0	24-0	2.19 15-0	57.06
31	4.1	2.3	2.3	428 194.5	....	1.92	....	86.28	29-0	....	....	15-0	30-0	8-6	18-0	25-0	2.26 15-0	60.96

The Water Supply and Storage Company has built about 45 miles of telephone line, at a cost of $7,000, extending only to the source of supply near the summit of the Rockies. The total cost of delivery under this system is estimated at $6,230, or about 17 cents per acre per year. This includes $750 of the salary of the president and superintendent, $5,000 for the ditch riders, who receive $3 per day each when employed, and $480 for office expenses. The salaries of the ditch riders include those paid to two men at Chambers Lake and on the Grand River Ditch, who receive $2.50 and $3 per day, respectively, and that paid to the headgate man on the main canal, who receives $100 per month and house rent.

THE CONSOLIDATED HOME SUPPLY SYSTEM.

The system of water delivery followed by the Consolidated Home Supply Ditch and Reservoir Company near Loveland is similar to that of the Water Supply and Storage Company, since this company depends chiefly on stored water during the entire season and entirely on it during the periods when water is most needed. This system consists of the Home Supply Canal, the Lone Tree and Mariana reservoirs, and the Home Supply reservoir ditch. The Home Supply Canal is the inlet for the Lone Tree reservoir and the direct source of supply for a portion of the land. Water is delivered to the rest of the land through the Home Supply reservoir ditch, which is the outlet of the Lone Tree reservoir. The Mariana reservoir, being below both the main canal and reservoir ditch, water stored in it is ex-

changed for river water.[a] The main Home Supply Canal and the reservoir ditch together have a total length of 28 miles and the laterals leading from them aggregate 12 miles in length. The combined capacities of the two reservoirs is about 590,000,000 cubic feet. The maximum flow in the main canal is 285 cubic feet per second, and the average when water is being run is about 225 cubic feet per second. The principal crop irrigated is sugar beets, and three irrigations are given. The largest acreage is in grain, 17,500 acres having been irrigated in 1908, 6,000 in alfalfa, 200 in potatoes, and 100 in native grasses. There are 179 irrigators who own the 2,000 shares of stock that have been issued.

PLAN OF DELIVERY.

Water delivery under this system is in charge of a superintendent, who has two ditch riders under him. At the beginning of each irrigation season (in April) the total amount of water stored in the reservoir is ascertained and a determination made of the number of days a 5-inch flow can be run for each share. A series of runs is made during the season and each user is allowed to receive water on demand during any run, provided he receives it for full-day periods and in quantities of not less than 5 inches.[b] In other words, he has in the reservoirs a definite quantity of water which he may draw on as freely as a depositor can draw on his funds in a bank, within reasonable limits of time and quantity. It is not necessary to regulate the amount he wishes nor the time he irrigates with any reference to irrigation by his neighbors. The farms are all comparatively close to the reservoirs, no long laterals are required, and there is little waste in delivering to one or two users. If any water remains at the end of the run a second run is given. Water in the Big Thompson is highest during May and June, making it possible to refill the reservoirs after the first part of the irrigation is completed. It happens sometimes that after the reservoirs have been refilled there is still a surplus in the river above the amount necessary to supply the canals having earlier priorities than the Home Supply system, when the irrigators under this system are then supplied "free" water directly from the river and no account is kept of it. In the latter part of June, 1908, a run of twenty-eight days was first made, this being the estimate of the superintendent for the season. Each shareholder was entitled to one hundred and forty 24-hour inches, to be drawn as desired. Later on it was found that a surplus would remain, and the length of the run was increased, first to thirty and then to thirty-

[a] U. S. Dept. Agr., Office Expt. Stas. Bul. 134.

[b] The inch used on this system is not the statute inch of Colorado—0.026 cubic foot per second—but 0.018 cubic foot per second.

one days. The supply for that year was below normal, the usual seasonal run being about forty days.

The superintendent of the Home Supply system has connection at his residence with the two local telephone lines, which cover the entire system, and receives calls for water from the farmers both morning and evening. Orders for turning the water on or off are given the ditch riders by the superintendent. The ditch rider in the upper division covers about 12 miles of canal and the one in the lower division about 15 miles. When any irrigator has drawn his full amount for any one run his headgate is locked securely and not opened again during the season unless an extra run is made.

Throughout this system Cipolletti weirs are used for measuring water to the farmers. Each ditch rider is supplied with a weir table and is instructed to make careful measurements. The flow over the weirs is regulated by steel gates similar to those on the North Poudre and Larimer County canals (fig. 5, p. 39). The facing of the headgate is usually of concrete, but sometimes of planking. On some portions of the system the ordinary undershot wooden headgates are used, placed at the upper end of a wooden box, but these are being displaced rapidly by the steel gates.

RECORDS AND EXPENSES.

The only permanent record of delivery kept is the superintendent's book, which shows the size of stream delivered to each water user and the days on which he receives it.

The plan followed by the ditch riders in keeping their records leaves little chance for mistake. As the orders are received each day from the irrigators their names, with the number of shares wanted and length of time to be run, are noted on cards for that day. Multiplying the number of shares wanted by 5 gives the number of inches to be run. These cards are taken by the ditch riders and the orders for turning the water on or off are carried out. The ditch riders make entry of all water being drawn throughout their respective beats and this record is copied into the superintendent's book, the names and amounts being checked off as this is done.

The superintendent of the Home Supply system receives a salary of $1,000 per year and the two ditch riders each receive an average of $2.50 per day, being paid more in the irrigating season and less in the winter. Allowing $800 for additional help at the headgates and on the ditches and $500 for office expenses, the amount charged to water delivery is $4,100 per year, or about 15 cents per acre. Part of this, however, should be charged to maintenance, as the superintendent and ditch riders devote their time in the winter to making repairs.

THE ROCKYFORD CANAL.

Sixteen ditches in the vicinity of Rockyford have substantially the same plan of delivery. The following description of the plan used on the Rockyford Canal will apply to the others:

The Rockyford Canal takes practically a uniform stream of 112 cubic feet per second from the Arkansas River through April, May, June, and a part of July. This water passes to about 200 irrigators through 16 miles of main canal and 95 miles of principal laterals. Some 10,000 acres are irrigated, consisting of about equal areas of alfalfa, grain, and sugar beets. Only one man is employed in water delivery. He lives at the headgate, the house being furnished by the company, and divides the supply to the laterals throughout the system. One man is able to do this work owing to the steady and uniform flow in the canal, his chief duties being to keep the gates and the canal free from obstructions after the lateral gates are properly set, the farmers themselves dividing the water after it is turned into the laterals. A record of the flow into the canal at the headgate only is kept.

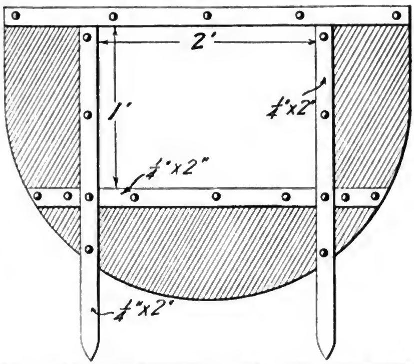

Fig. 6.—Portable galvanized-iron weir used on the Rockyford Canal.

According to the by-laws of the Rockyford Ditch Company, water is to be prorated among the users in proportion to the number of shares held by each, but "the company shall not, and does not, guarantee to the holders of stock the use at all times of the full amount of water they are respectively entitled to," but "in order that the water may be equitably distributed among the stockholders, the directors and the persons intrusted by them with the management of the ditch are empowered to rotate water among consumers, or to divide the ditch into districts for the distribution of water, or to adopt such other methods as in their judgment may from time to time become necessary to secure to all stockholders their proportionate share of water." The steady flow in the canal seems to render rotating unnecessary and the usual practice is to deliver individual streams to the various users.

The ditch rider is supplied with a galvanized-iron portable rectangular weir, of which a sketch is shown in figure 6. It is braced

with ¼ by 2 inch iron straps, the vertical braces extending below the galvanized-iron sheet to serve as feet. The crest is 2 feet long. When the ditch rider wishes to set a lateral gate he closes it and selects a suitable place in the lateral to set the weir. After setting the weir and leveling it by admitting a small stream, he opens the gate so that the required amount of water will flow over the weir. Where two or more irrigators take water from the same lateral, division is made by means of a simple flume, into which the water falls and is divided by a board 6 inches high dividing the flume, proportionally to the number of shares the irrigators are to receive.

The ditch rider on the Rockyford Canal receives $75 per month when employed and the total annual expenses chargeable to water delivery are $800, or 8 cents per acre.

SYSTEMS USED ON TYPICAL CANALS IN WYOMING, MONTANA, AND IDAHO.

THE WHEATLAND CANAL.

The Wyoming Development Company's canal system at Wheatland, Wyo., is the largest system outside of government works in southeastern Wyoming, and is typical of irrigation canals in that portion of the Rocky Mountains where grain and alfalfa are the principal crops irrigated. The water supply comes from the Laramie River through three principal canals, canals 1 and 2 leading to the irrigated fields and canal No. 3 being a reservoir supply ditch. The total length of the three main canals is 54 miles and the aggregate length of the laterals leading from them is 100 miles. The total area irrigated in 1908 was estimated at 30,245 acres, of which 10,000 acres was in alfalfa and 19,500 in grain. The maximum flow in canals 1 and 2 is 700 cubic feet per second, and the average 440 cubic feet per second. Three hundred and fifty irrigators receive water from the system. Water rights, or shares, in the canal system were sold to the settlers as an inseparable part of the land purchased, on the basis of 1 cubic foot per second continuous flow for each 80 acres. Each irrigator is entitled, consequently, to receive water in proportion to his land area.

Water delivery is in charge of a general superintendent, the work being performed by 5 ditch riders, each of whom has charge of 5 to 10 miles of main canal and the laterals leading from it in his section. The water supply of the system at present is much more than is needed, and as a consequence it has not been necessary to perfect a plan of water delivery. Water is delivered in continuous flow at the rate of about 1.5 cubic feet per second for each 80 acres irrigated. A continuous flow of 1 cubic foot per second for each 70 acres is the maximum amount for which a water right can accrue under the

Wyoming law, but this limit is not enforced in actual water distribution unless the failure to do so would deprive some regularly adjudicated priority of its share. Each ditch rider receives the proportional part of the entire flow due to irrigators served by him and distributes it in accordance with the shares owned by each. In some cases the ditch riders make delivery to the individual users and in others only to the laterals, leaving the individual deliveries under such laterals to be made by the users themselves.

Each lateral has an organization subsidiary to the main canal company, which owns and controls both the laterals and sublaterals. These lateral organizations are independent of the main company except in case of disagreement, when the advice of the general superintendent is relied upon to straighten out the tangle. At the beginning of the season each lateral organization selects one of its members to act as ditch boss, whose duty it is to oversee the cleaning and repair of the lateral and its branches, to put dividing boxes and weirs in proper condition and adjustment, and to see that each irrigator receives his share of water. All expenses connected with both construction and maintenance of these laterals are borne by the lateral companies, and when a new farmer comes in he is required to pay into the treasury his share of the cost of construction.

The only regular and continuous water measurements taken on the system are at the headgates of the main canals. Records of these are preserved in the office of the company. The only devices in use in measuring water to the farmers are flumes 8 to 10 feet long, with weirs across them 12 to 15 inches high, made by the farmers. Accurate measurements are not attempted, and the measuring devices afford no suggestion to other systems. Streams are subdivided with flumes divided into longitudinal compartments having uniform weirs and proportional in width to the share of water each should receive.

No written rules and regulations governing the delivery of water are in force, and no form of application for water is used, each irrigator usually leaving a note at the headgate of his lateral whenever he desires water to be turned to him. A telephone line costing about $500 and covering practically the entire system has been constructed. The canal company owns shares in this telephone line.

The total cost of water delivery under the system is given as $3,200 per year, or only about 11 cents per acre. This is made up of $1,200 as part of the salary of the general manager and superintendent, $1,700 paid to ditch riders from April 15 to September 15 at $65 per month each, and $300 for office expenses.

THE FARMERS' CANAL COMPANY.

A typical irrigating canal of Montana is that of the Farmers' Canal Company at Bozeman, which receives water from the West

Gallatin River and supplies 15,000 acres of grain, clover, alfalfa, and potatoes. The main canal is 15 miles long, with a maximum capacity of 300 cubic feet per second and distributaries aggregating 25 miles in length. The company is a cooperative organization of 60 irrigators. The by-laws provide for two series of stock, each share of the first series entitling the holder to the use of $89\frac{2}{7}$ inches of water and each of the second series to a continuous flow of $61\frac{17}{28}$ inches. Each irrigator usually owns one share of each series. The company is not concerned with water delivery after the water has been turned into the laterals. A canal walker is employed for two months, from June 10 to August 10, at a salary usually of $90 per month, to patrol the ditch banks and divide the water between the laterals. He is subject to instructions from the president of the company, who has full charge of water delivery and receives $1.50 per day for each day actually spent on the canal, averaging about $40 per year. A superintendent is employed also at $4.50 per day whenever repair work is necessary.

Water is delivered in a continuous flow, if desired in that way by the irrigator. The president and canal walker only have authority to make or permit changes in the headgates. Tampering with the gates, except when it is necessary to repair breaks or to avert damage, is subject to a fine of $50. This penalty was enforced once, since which time there has been no trouble. In case of a surplus or a scarcity each irrigator receives his proportion of the total supply available, and handles an average of about 100 miner's inches, or 2.5 cubic feet per second, as an irrigating head, and in exceptional cases irrigators have been known to use as much as 200 inches, or 5 cubic feet per second.

A Cipolletti weir has been placed 20 to 30 feet below the headgate of each lateral or farmer's ditch. The regulating gates are substantially constructed and the canal walker is able to run the amount required over the weirs with little difficulty. It is the opinion of a local observer that the secret of success lies in the use of the weirs, good headgates, and the division of the water by a disinterested canal walker. No records are kept of the delivery to the various irrigators. If the irrigators desire water when it is not running in their ditches, they make application to the canal walker. The management contemplates providing for written notices when it is desired to have water turned on or shut off.

The cost of delivery under this system is less than that under any system considered in this report, being only 1.5 cents per acre per year. This low cost is due to the fact that the regular irrigating season lasts only two months, that only general farm crops are grown,

that no attempt is made to control delivery except from the main canal, and that no records are kept.

THE NAMPA-MERIDIAN IRRIGATION DISTRICT.

Water delivery in the Nampa-Meridian Irrigation District, in Idaho, is under the control of a managing director, who receives $3 per day for the time employed. He has under him a foreman or overseer at $125 per month, a headgate man at $75 per month, a night headgate man at $60 per month, and eleven ditch riders at $65 per month. The main canal is 50 miles in length and there are 114 miles of principal laterals. Each ditch rider covers about 15 miles of canal every day. The average flow in the canals is 470 cubic feet per second, and 1,000 irrigators are supplied. Each irrigator is given a continuous flow for the length of time desired, the size of stream depending upon his water right or the amount applied for.

At each point of delivery from the main canal the company maintains a small box in which the irrigators place their applications for water. The ditch rider, after looking over these orders and adjusting the flow to supply them, places a card in the box stating the amount passing over the weir and for whom it is intended. A private telephone line covers the entire system. At 7 o'clock each morning the ditch riders report the stage of water in the various portions of the main canal and laterals to the foreman and receive orders regarding changes during the day. Below is given the form used for making applications for water:

Form used for making application for water from the Nampa-Meridian irrigation district.

TO CUSTOMERS.

Please deposit this card in the lateral lock box.

N-M Irrigation Dist.
Date .... 1908.
Turn water in ....
Lateral No. .... on
(Date) .... and
until further notice, as follows:
.............................., *Water Master.*

FOR ACCT. OF—	Inches.
....	....
....	....
....	....
....	....
....	....
....	....

SYSTEMS USED ON TYPICAL CANALS IN UTAH.

THE BEAR RIVER CANAL.

The Bear River Canal, in the north-central part of Utah, is the most extensive and important feature in the irrigation of Bear Valley lands and the largest system in the State. The land covered by it was originally a ranch of 125,000 acres lying on both sides of the Bear River in the vicinities of Corinne, Bear River City, and Garland. The project was completed in 1894 at a reported cost of $2,000,000. During the first nine years the canal passed through the hands of receivers three times, and in 1903 was bought by the Utah Sugar Company for $350,000, and has been operated successfully by them. The system comprises two main canals, West Side and East Side canals, the latter supplying only a small acreage, as 500 cubic feet per second is used for power. The maximum flow in the West Side Canal is 565 cubic feet per second and the average flow 385 cubic feet per second. In 1908, 34,000 acres were irrigated, 7,500 of which were in alfalfa, 15,000 in grain, 4,800 in sugar beets, and 800 in orchards. This canal is 49 miles long and has 50 miles of principal laterals owned by the company and about 100 miles of laterals leading from it owned by the consumers. Water is delivered under 1,200 contracts.

PLAN OF DELIVERY.

The same force attends to both water delivery and maintenance. The chief engineer receives a salary of $3,000 per annum, with residence, light, teams, and traveling expenses when away from home and under him are a general foreman at $90 per month, an assistant foreman at $75 per month, six ditch riders at $75 per month during the irrigation season, and four cleaning gangs. Delivery is directly under the charge of the general foreman, to whom the ditch riders report. The ditch riders are assigned to the same divisions year after year and are thoroughly familiar with their work and with the farmers with whom they have to deal. Each ditch rider controls about 10 miles of canal, and in addition to the work of delivery is responsible for the condition of the canal in his division and is expected to keep the chief engineer and general foreman thoroughly informed on all matters of importance. All disputes between the ditch riders and the farmers regarding the delivery of water are referred to the general foreman or the chief engineer. The chief engineer writes regarding the ditch riders:

> They are married and own farms in the districts which they operate. They are cool-headed men who do not assume a high and mighty attitude with the farmers. They are instructed to work for the best interests of the water users as well as for the company and at no time to abuse the water users in case of disputes.

The water delivery is in general governed by sections 11 and 12 of the terms and conditions of sale of water made a part of the contract between the Utah Sugar Company and the individual water users. Section 11 and the essential part of section 12 are as follows:

SEC. 11. That the use of water contracted for shall be governed and regulated by the company; and the latter may from time to time either allot to the consumer certain hours for the use of water (of which allotments it shall cause him to be duly notified), or, at its option, may give the consumer a continuous flow. That the consumer shall use the water furnished him carefully and without waste. That all gates, weirs, or other devices for the distribution of water on the company's canal and laterals shall be owned and controlled by the latter. That water shall be delivered by the company into a lateral or ditch to be provided by the consumer from a box or weir through the banks of the company's canal or lateral to be provided by it. That the consumer will use no more water than his contract authorizes and only at such stated times as shall be designated by the company and distributed to him by its water master, and will not furnish water to any other person on penalty of forfeiting his right to use of water during the remainder of the season.

SEC. 12. * * * That in case of shortage the company may alternate the use of water among its various consumers, or may distribute the available water pro rata to all its consumers in accordance with such rules and regulations as the company may from time to time deem necessary or expedient.

Originally the chief engineer desired to deliver water to each irrigator in continuous flow, because he felt that delivery in rotation—the general practice in Utah—would place too great a burden on the company, but the water users objected to this arrangement and he was compelled to work out a plan of rotation. This plan provides for a continuous flow in the main canal and in all of the principal laterals, whether owned by the company or by the consumers. The consumers' laterals have been laid out so as to cover an acreage sufficient to require a continuous flow of at least 2.1 cubic feet per second, and water is delivered to all consumers at that rate one hour per week for each acre, regardless of the crop. About four irrigation turns are required for the consumers to water their entire holdings, and consequently they get over the land about once each month during the irrigation season, May 15 to October 15. The minimum acreage under a consumer's lateral is 168, equal to the number of hours in a week. In case of a larger acreage the flow is increased accordingly. The farmers usually like to have an irrigating stream of 2 to 4 cubic feet per second, and a schedule of rotation for the consumers' laterals is arranged by the chief engineer at the beginning of each season and adhered to strictly. This schedule gives the exact time each consumer is to receive water each week. Copies of this are given to the ditch riders and notices sent to consumers, and there is no possibility of controversy as to the time water is due. The following is a copy of the forms used.

Form used by the Utah-Idaho Sugar Company to notify consumers of time they are to receive water each week throughout a season.

No. 5972.

UTAH-IDAHO SUGAR COMPANY.

Date......, 190..

Mr.......................................

....

Acres...., Sec...., Tp..... R.......

From......M............................

Until......M............................

$...... By ....

UTAH-IDAHO SUGAR COMPANY. No. 5972.

GARLAND, UTAH, ..., 190..

Mr......

DEAR SIR: Without recognizing any contracts except those made by this company and the Bear River Water Company, your schedule of time for irrigating ...... acres in Sec. ...., Tp. .... N., R. .... W., during the irrigation season of A. D. 190., will be from .... M. .... until .... M. ...... flow.

UTAH-IDAHO SUGAR COMPANY,
Per ....

Water rentals are due May 1, and bear interest at 7 per cent until November 1 and 12 per cent thereafter until paid.

Water is used both day and night, the schedule being changed each year, so that a consumer is not required to do most of his irrigating at night two seasons in succession. The rotation begins with the farmer nearest the turn-out from the main lateral. If any farmer does not wish to irrigate when his turn comes, he is allowed to shut the gate leading to his individual distributing ditch. Each farmer is required to take care of his waste, and as he usually does not have waste ditches it is necessary for him to shut off the supply when no longer needed. This method has proven very satisfactory.

The schedule of irrigation prepared by the chief engineer is supplied to the ditch riders on regular forms on loose leaves for insertion in their field books. This form shows the number of the box from which water is taken, the schedule number by which the farmer is located on the books in the office, the area irrigated, the exact location of the land, the number of the contract under which he is entitled to water, the number of hours for which the stream is to run, the exact time he is to begin taking water, and the exact time that he is to cease.

MEASUREMENTS AND EXPENSES.

Measurements of water under this system are made almost entirely with current meters by a hydrographer employed for six months each year at a salary of $80 to $100 per month. He measures the water both in the main and branch canals and reports to the chief engineer. After the flow in the consumer's ditch is measured the turn-out gate is set and locked at a point that will pass the amount of water called for by the schedule. The chief engineer intends to have every stream delivered to a consumer measured at least once each week during the season, but this can not be done by one man. He succeeds, however, in getting enough measurements to enable him to keep the required amount of water flowing in the consumers' laterals with approximate accuracy.

All of the turn-out gates are owned by the company. In the early days of the canal the consumers were allowed to install their own, but the company claims that these parties have caused much trouble by breaking locks and otherwise molesting the canal, as they have a legal right to remove locks put on their private turn-outs by the company. The turn-outs on the branch canals are numbered consecutively from the turn-out in the main canal. The ditch riders keep careful crop reports for their respective districts, showing the acreage in various crops and the yield of each. The management of the canal finds these crop reports to be good evidence of the kind of water service the consumers get, and in case of dispute use them to refute claims of poor service.

All consumers receiving water from this canal are required to purchase perpetual water rights, costing $35, one-fourth down and the balance in three annual installments, with interest at 6 per cent per annum, and 12 per cent if not paid when due. In addition to the water right, annual rentals are charged to consumers at $1 per acre on land devoted to general farming, $2.50 per acre on land planted to orchards exceeding 5 years old, and $4.50 per acre on city or town lots. The company sought to make the charge increase with the ability of the farmers to pay, but this did not prove satisfactory to the farmers, as it is a well-known fact that less water is required to irrigate orchards than alfalfa.

Water rentals are due for the current year on May 1, and bear interest at 7 per cent until November 1 and at 12 per cent thereafter until paid. Those delinquent in the payment of rentals are required to make satisfactory arrangements with the company before they can receive water.

The annual cost of water delivery is not segregated in the annual reports of the chief engineer. The chief engineer receives $3,000 per annum, one-third of which should probably be charged to water delivery. The general foreman receives $90 per month, the hydrographer $80 to $100 per month when employed, assistant foreman $75 per month, and six ditch riders $75 per month each, or a total for salaries of those concerned in maintenance and operation exclusively of about $8,000. Charging one-half of this to water delivery and $1,500 per year for office expenses, which is the estimate of the chief engineer, makes a total chargeable to water delivery of $5,500, or about 16 cents per acre.

THE DAVIS AND WEBER COUNTIES CANAL.

The Davis and Weber Counties Canal, which receives water from Weber River and East Canyon Creek, is perhaps one of the best examples of a fairly efficient water delivery under simple and inex-

pensive methods worked out by the farmers themselves. This canal irrigates about 12,000 acres planted to alfalfa, grain, sugar beets, tomatoes, and other crops, with an average flow in its main canal of not more than 150 cubic feet per second. The company which controls the canal is made up of 520 water users. All who have rights to the normal flow of the water sources own primary rights, as is the case with practically all canals in Utah, sharing in such normal flow pro rata according to the number of shares of stock owned. In addition to primary rights, secondary rights have been issued to the flood flow, the holders sharing pro rata with the holders of the primary rights in the total flow of the canal during flood season but are not entitled to water when the floods have passed. This canal was known originally as the Central Canal, and when organized by the present company was receiving its water from the Weber River only. The river, however, soon proved inadequate, and additional stock was issued for the purpose of constructing a reservoir in East Canyon Creek. In the middle of July, when there is not sufficient water in the Weber River to supply the rights, the reservoir is drawn upon and the crops under the canal thus matured.

The total length of the main canal is 9 miles and there are only about 10 miles of main laterals, known as south, west, and north branches. The company attends to water delivery from this main canal and these main branches. There are 15 additional laterals, averaging 1.25 to 7 miles and aggregating 60 miles in length, from which the water is distributed by the irrigators without any expense to the company. There is a superintendent or chief watermaster, who is in charge both of maintenance and operation, at a salary of $4 per day when employed, his total salary in 1907 having been $737. Directly under the chief watermaster is a subwatermaster, whose duties are confined to water delivery and who receives the same rate of pay as the chief watermaster. There are two ditch riders, who patrol the channels, keep them clear of weeds and other obstructions, and prevent and repair breaks, but have no other duties connected with the delivery of water.

Each lateral has a watermaster, who is appointed each year. Some of these receive compensation at the rate of 15 or 20 cents per share of stock, some monthly salaries, and others no compensation. These watermasters receive the water from the main canal or one of its main branches and deliver it to the users under their respective laterals in regular rotation. The usual amount delivered is 4.3 cubic feet per second per acre for one-half hour, regardless of the crop, the intervals between irrigations being six to twelve days, depending upon the individual ideas of the various farmers. At the beginning of each season the secretary of the company sends a card to each watermaster

for each irrigator on his lateral, showing the amount of water the irrigator is to receive during the season, and these cards form the watermaster's basis for delivery. These cards are reissued each year, owing to changes from one lateral to another, through rental of shares, and other causes.

No water measurements are taken, and gage readings are taken only occasionally at a rating flume near the head of the canal, but no record of them is kept. The superintendent and subwatermasters are expected to be experts in guessing. The lack of measurements results in a great deal of dissatisfaction during periods of scarcity, and, while many of the irrigators realize the value of them, the inherent desire of the majority to incur no expense not actually necessary has prevented the installation of additional devices.

The cost of water delivery under this canal is merely the cost of employing the superintendent and subwatermasters and the office expenses. The total properly chargeable to delivery in 1907 was not over 10 cents per acre.

THE SOUTH JORDAN CANAL.

The South Jordan Canal receives its supply from the Jordan River, and waters 9,000 acres of alfalfa, grain, and sugar beets south of Murray. It is 18 miles long, has 42 laterals averaging 2 miles in length, and maintains a maximum flow of 142 cubic feet per second during the principal part of the irrigation season. The company is made up of farmers using the water carried, 6,000 shares having been issued at the average rate of one share to each 1.5 acres irrigated. Each share entitles the owner to $\frac{1}{6000}$ of the available supply.

Water delivery is attended to by a watermaster, who receives about $400 per year, being $3 per day for the time actually employed. He arranges and executes his plan of delivery, subject to the direction of the board of directors. At the beginning of each season he is furnished a list showing the number of shares owned by each shareholder on each lateral. The number held on the several laterals varies slightly from year to year, owing to sales and rentals. On receipt of this list, the watermaster turns to each lateral the proportion of the entire supply due all of the shareholders under it, and this volume runs as a continuous stream throughout the season, except during exceedingly dry periods. Exceptions are made for laterals on which less than 200 shares are held, in which case two or more such laterals are combined and treated as one. The duty of the watermaster ends with the division of the water to the laterals. The users on each lateral arrange among themselves a schedule of rotation and appoint one of their number, at a compensation, usually of 10 cents per share per year, to see that the schedule is carried

through. The largest stream carried by any lateral is represented by 448 shares, which amounts to 6.5 cubic feet per second when the canal is carrying its full 142 cubic feet per second. The smallest stream is represented by 48 shares, or 0.65 cubic foot per second. In the former case each user receives the full flow for thirty-five minutes for each share owned, and in the latter three hours per share. On nearly all the laterals water is delivered on the basis of one hour per share for each run, runs being so timed that each user receives water every nine or ten days throughout the irrigating season from April 15 to September 15. About 356 irrigators are supplied by the canal.

This canal is one of five taking water from the Jordan River under a court decree defining their respective rights. Measurements are made by a court commissioner, twice each week during the irrigation season, in a rating flume at the head of the canal, and a gage rod is read twice each day. The flow to the laterals is measured over Cipolletti weirs installed short distances below the heads of the laterals. These weirs are made of lumber, without metal crests or sides, and all of the conditions necessary for accurate measurements are not maintained. The velocity of approach, however, is not allowed to exceed 0.5 foot per second, and the results are considered satisfactory by the farmers and are approximately correct.

No daily record of delivery of water to irrigators is kept by the watermaster, such a record not being necessary, as the distribution among the users on the various laterals is arranged among themselves without reference to the watermaster. No record is kept of the amount delivered into the laterals, as the flow is kept as nearly constant throughout the season as the flow in the canal will permit, and much of the fluctuation in the canal is borne equally by the various laterals. The flow in the various laterals is affected to some extent by differences in the grade, size of opening of the outlet from the main channel, obstructions in the canal and laterals, and it is necessary for the watermaster to spend much of his time along the canal adjusting headgates, removing obstructions as they accumulate, and making measurements at each weir three times a week. Satisfactory delivery under this system is prevented by the growth of water grass in the canal, which has a tendency to hold the water at a high level in the canal, thus increasing the discharge through some of the headgates.

The total annual cost of water delivery averages about $1,350, or 15 cents per acre, of which about $150 is paid to the secretary, $400 to the watermaster, and about $200 for the services of the court commissioner at the headgate. The remaining $600 is for maintaining the schedules on sublaterals, at 10 cents per share.

THE UTAH AND SALT LAKE CANAL.

This canal takes water from the Jordan River. Like the South Jordan Canal, its supply is apportioned by a commissioner of the district court, the rating flume at the head of the canal being rated by the court commissioner at the same time as that of the South Jordan Canal. The main canal is 26 miles long, with 52 lateral ditches from 1.5 to 2 miles long. The canal irrigates about 13,000 acres, 9,000 in alfalfa and 3,000 in grain. The maximum capactiy is 246 cubic feet per second, and the average flow about 200 cubic feet per second. The ownership in the canal is represented by 10,000 shares of the Utah and Salt Lake Canal Company, controlled by 510 irrigators.

The plan of delivery is similar to that followed on the South Jordan Canal except that instead of using Cipolletti weirs of standard length and altering the depth of flow over them according to the quantity to be run, the watermaster has installed rectangular weirs with lengths proportional to the number of shares represented on the laterals, and the depth of water over the crests of all of these weirs is maintained equal or as nearly so as possible. Each share on a lateral is represented by one-eighth of an inch in length of weir crest. When shares are transferred from one lateral to another the weirs are increased in length by sawing off a portion of one or both sides, or decreased by nailing on cleats. These alterations are made at the beginning of each season, as practically no transfers are made after irrigation begins. This method of altering the size of the weirs is crude but easy and is accepted as satisfactory by most of the water users. The weir boards are made of 1 and 2 inch material and the crests and sides are not beveled to give a thin edge. The proper conditions of the grade and the width and depth beyond and below the crests are not maintained and the velocity of approach therefore varies considerably, so that in reality the measurements are little more than approximations.

The watermaster is provided at the beginning of the season with a list of shareholders, segregated by laterals. There is also some one on each lateral who looks after the division among the farmers on the lateral, receiving pay from his neighbors at the rate of 5 cents per share per year, either in cash or in water.

The size of stream delivered depends upon the number of shares each user owns. The smallest stream is delivered to the owners of 68 shares, being 1.36 cubic feet per second when the average of 200 cubic feet per second is carried in the main canal. Each user receives this stream for one hour per share at each irrigation, the intervals between irrigations being eight or nine days, as arranged by the users on each lateral. The largest stream is that delivered to the owners of

522 shares, and amounts to 10.44 cubic feet per second, and is allowed for twenty minutes per share at each irrigation.

The watermaster receives $3 per day for the time actually employed. amounting to about $500 per year. The secretary receives $300 per year, of which $200 is properly chargeable to distribution. Counting the amount paid to subwatermasters on the laterals, at the rate of 5 cents per share per year, the total expense properly chargeable to delivery is approximately $1,200 per year, or a little over 9 cents per acre.

THE UPPER CANAL IRRIGATION COMPANY.

The Upper Canal is a small canal receiving water from Big Cottonwood Creek near Murray, and supplying a total of 1,500 acres of land farmed by 184 farmers. Alfalfa is the chief crop, but the section covered by the canal is a rather favored orchard belt, about 300 acres being in fruit trees, nursery stock, and grain. The main canal is only 15 miles long, beginning in Big Cottonwood Creek at the point of intake of the conduit supplying Salt Lake City. There are 57 small laterals, aggregating 23 miles in length. On 32 of these laterals water is run during the entire year for stock and domestic purposes. The maximum flow is 60 cubic feet per second and the average only about one-half of that amount.

Water delivery under this system is attended to by one man, who receives a salary of $270 and is employed only during the summer months. Water is delivered on a time basis and is measured over small Cipolletti weirs set in the channels of the canals without boxes or flumes. The irrigation schedule is followed very carefully and irrigators receive water in proportion to the shares of stock owned. The amount delivered for orchards, potatoes, berries, and nursery stock is 2 cubic feet per second; for grain, 3 cubic feet per second; and for alfalfa, 4 cubic feet per second. The water is run two hours for all crops receiving an irrigating head of 2 cubic feet per second, one and one-half hours for grain, which receives a head of 3 cubic feet per second, and one hour for alfalfa, which receives a head of 4 cubic feet per second.

The plan of delivery on this system is very simple, yet it seems to be all that is necessary. Each irrigator knows what his share is and relies on the ditch tender to see that he gets it. No records are kept of the measurements on the laterals, but a record is kept showing the flow in the main canal.

The only expense for water delivery is the salary of the ditch tender, and the cost per acre is only about 18 cents per year.

SYSTEMS USED ON TYPICAL CANALS IN NEW MEXICO AND ARIZONA.

THE NORTHERN CANAL IN NEW MEXICO.

The Northern Canal at Hagerman, owned and operated by the Hagerman Irrigation Company, has its sources of supply in North and South Springs and Berindo rivers and artesian wells. The main canal is 35 miles long and the aggregate length of the principal laterals is 75 miles. Ten thousand acres are irrigated by the canal, 4,000 in alfalfa and 6,000 in orchards, with corn, alfalfa, and potatoes between the rows in about one-third of the orchards. The maximum flow in the main canal is 180 cubic feet per second, and the average flow during the irrigating season from March 1 to November 1, 57 cubic feet per second. One hundred and sixty-five irrigators are supplied by the canal, all of the shareholders being irrigators.

This canal, although one of the smaller of the systems considered in this bulletin, has relatively one of the most complete systems of water delivery. It is under the direct supervision of a water superintendent who has two ditch riders under him. The superintendent directs both the canal maintenance and the water delivery, there being no engineer. He also performs all clerical work connected with the system. Each ditch rider covers 8 miles of main canal and 35 miles of laterals. The superintendent gives them written instructions, indicating the importance attached to accuracy and faithfulness on the part of the ditch riders. These instructions are given in full below:

Written instructions to ditch riders of the Hagerman Irrigation Company.

HAGERMAN, N. MEX.

Mr. ——— ———,

Ditch rider, District No. ——.

DEAR SIR: 1. In your capacity as ditch rider for this company, it will be your duty to take proper care of all gates, weirs, measuring boxes or flumes used for the delivery of water to the consumer, and when same are out of repair and you are unable to make necessary repairs, you will promptly notify this office.

2. I wish you to exercise the greatest care in handling of water. Be sure that you are correct on all measurements, and before you time water through measuring box, flume, or weir, see that it is clear and true.

3. Be prompt in making your settlements with consumer. It will save you time and trouble and will be more satisfactory to all concerned.

4. Turn in your daily records on the first of each month and water cards not later than 10th of each month.

5. You will deliver no water on "water right" land until first having received notice from this office that rents due have been paid on said land.

6. You may require that twenty-four hours' notice be given for the delivery of water, and six hours' notice for shutting off same.

7. Parties buying special water will be required to provide all necessary ditches, gates, weirs, etc., for the delivery of same.

8. Notify all parties receiving "special" or "excess" water that no deliveries will be made for amounts less than $1.

9. You will promptly notify all property holders who have fences, bridges, or other obstructions across the canal or main laterals that they must keep them out of the water, and must not set posts or other obstructions that will catch moss or trash of any kind, and thereby obstruct the free flow of water through said canal and lateral.

10. You will be expected to use every courtesy in your treatment and business transactions with the farmers, be ever ready to consider any claim or grievance they may have to present, be fair yet firm in your decisions, be sure that each one understands the honesty of your purpose and that you are trying to give all the best possible service.

——— ———,
Superintendent.

Under the water rights issued the consumers are entitled to receive 30 acre-inches of water per acre per annum, or 108,900 cubic feet, for which they pay $1.25. Water in excess of this amount is charged for at 5 cents per acre-inch, or 3,630 cubic feet. The consumers notify the ditch rider when water is wanted and the amount desired, and it is delivered as near that time as the supply permits. A regular form for application for water is provided, but this is not used in making applications for water, being filled out by the ditch rider in duplicate and signed by the consumer at the time of delivery. The original is kept by the ditch rider and turned into the office of the superintendent at the end of the month and the duplicate is retained by the consumer.

The usual size of stream delivered to irrigators is 3 cubic feet per second for orchards and 5 to 8 cubic feet per second for alfalfa. Time rotation is not followed on the system. Cipolletti weirs and rated measuring flumes are used for measuring water to the consumers, there being 105 such devices on the system. Weirs are used where the canal grade is sufficient to give a free overfall, and where it is not sufficient measuring flumes are used. The policy of the company is to measure water to each consumer separately and at a point as near to the consumer's headgate as possible, except in cases where consumers are located so that one measuring device will answer for more than one.

Daily records of the amount of water running through each headgate are kept on small slips and turned in to the superintendent at the end of each month and show the total amount of water allowed to each user.

For the monthly report made to the directors a form is used providing spaces for the name of each user, the number of acres irrigated, the total number of cubic feet used up to the end of the month for which the report is given, the excess over the allowance on the water-right contract delivered to each user, the "special" water used

during each month, and the amount due on "excess" and "special" water for the month. A ledger account also is kept for each individual consumer, showing when water was delivered and how the account of each consumer stands.

In addition to furnishing a basis for water charges and as a check to delivery the above report gives approximate data regarding the duty of water under the canal. The superintendent reports that after thirteen years of experience with the present system he "can testify that the farmers seem entirely satisfied with the manner of distribution and delivery and are not asking or making suggestions for any change."

The total cost of water delivery under the Northern Canal is placed by the superintendent at $1,490 per year, or about 15 cents per acre. This includes one-third of the superintendent's salary of $100 per month, $1,050 paid to the two ditch riders at $75 per month each, and $40 for office expenses.

THE TEMPE CANAL IN ARIZONA.

The Tempe Irrigating Canal supplies water from Salt River to 185 irrigators at Tempe, Ariz., and is owned and operated by the farmers using the water. The main canal is only 4 miles long, and supplies 34 miles of principal laterals and waters 21,600 acres—14,000 in alfalfa and 7,000 in grain. The maximum flow in the canal is 475 cubic feet per second and the average flow throughout the year 145 cubic feet per second.

Water delivery is under the direct charge of a superintendent who receives $110 a month and who has under him two zanjeros at $85 per month each. He has entire charge of both maintenance and delivery under the general direction of the board of directors. Each zanjero covers about 20 miles of canal and laterals, and often finds it necessary to ride 35 or 40 miles a day. The cost of delivery averages 14 cents per acre per year.

Water is delivered in rotation, the length of time each user receives it depending upon the number of shares owned, which is not uniform, as some land requires more water than other land and the irrigators have bartered the stock among themselves until each holds the number of shares necessary to supply the water required. It is customary to keep a steady flow in each of the main laterals and to rotate on these laterals, starting at the upper end of each. The amount to be delivered to each user depends on the supply available, being usually 400 to 1,000 miner's inches, or 10 to 25 cubic feet per second. The superintendent notifies the zanjeros of the size of stream in the main laterals, who distribute such flow in accordance with their general instructions and the amount due each irrigator.

The way in which this is done is shown by the following description furnished by C. G. Jones, president of the company:

We distribute water according to the number of shares owned in the canal and usually run it for twenty-four hours to 1 share, twelve hours to ½ share, six hours to ¼ share, etc., the stream or irrigating head run to each irrigator varying from 400 to 600 inches.

We will suppose that the superintendent notifies the zanjero that at 12 o'clock noon, June 1, 1,800 inches, or 45 cubic feet per second, will be turned into the head of a principal lateral, to be divided into 3 irrigating heads. The zanjero then notifies the first irrigator on sublateral No. 1 that his head of water will be turned to him at 12 o'clock noon on June 1, presuming that sublateral No. 1 takes out close to the head of the principal lateral. This user is told that he will receive water forty-eight hours. The zanjero then goes to sublateral No. 2 and notifies the first user (A) that the second head will be turned into sublateral No. 2 at 12.30 p. m., June 1, which allows thirty minutes for water to run from the head of the principal lateral to the head of sublateral No. 2; the zanjero also notifies the second user (B) on sublateral No. 2 when water will be turned in sublateral No. 2, that A will use it for the first six hours and will then turn it down at 6.30 p. m. the same day to B. The zanjero also tells B to see that A turns it down on time, and should A refuse to turn it down on time no water will be given him at the next run, and he may be prosecuted under the law. Prosecution under the law, however, is unnecessary. B receives the water at 6.45 p. m., allowing fifteen minutes for it to run from A's check, and uses it for nine hours, when he turns it down to C. In the meantime the zanjero has notified C and D and E as he has A and B when the water is turned into sublateral No. 2 at what time each should receive it and turn it on to the next user. When the number of hours on sublateral No. 2 has been run the zanjero closes the headgate at the principal lateral. A has now had water for six hours, B for nine hours, etc., in all fifty-four hours. In the meantime the third head of water has also been turned from the principal lateral, first going into sublateral No. 3 at 1 p. m. on June 1, the day the first two heads were turned out above. As the users on sublateral No. 3 have the least number of hours to run the third head will first be ready to be returned to the main lateral. The time for this is 12.30 o'clock midnight, June 3, the water on this head going to sublateral No. 4 for twelve hours. Now at noon, June 3, the head in sublateral No. 1 is out and it will be turned to sublateral No. 5 for eighty-four hours. Thus as the runs in the sublaterals above are completed the heads are taken down to the sublaterals below until all are served with their proper number of hours, when rotation is begun over again, starting as before with sublateral No. 1. When the river is normal, or above normal, irrigators will receive irrigating heads every six to ten days. As this is a suitable length of time between irrigations for practically all crops, we make no special difference between users on account of crop grown. Irrigators can receive no water except in regular turn and after having been verbally notified by the zanjero of the time water is to be delivered.

Our plan of delivery has been in practice for a number of years and has been perfected from time to time as occasion has required. It is now considered the best system in the Southwest for distributing water from a river with an irregular flow where the farming is stock raising and the growth of hay and grain.

The superintendent keeps a record of all water delivered to the canal system, made up from reports received twice a day from the gage reader on the river. He also keeps an accurate account of the amount turned into each principal lateral, this amount being in proportion to the number of shares owned on such lateral and divided into irrigating heads as he may direct. These heads are measured and checked by means of sections that have been rated with a current meter, sometimes as often as twice a month, each rating section being provided with the customary gage rods. The measurements reported to the superintendent are kept in a book for that purpose. The zanjeros also keep account of the amount of water and the number of hours run to each irrigator.

The following brief rules and regulations are the only written guide for the zanjeros relating to the delivery of water.

Rules governing water delivery.

1. That no small stream or head of water, except in regular turns, shall be run for watering of stock.
2. That no one except such as are duly authorized by the board of directors shall handle any gates or checks in the canal or branches.
3. That when assessments are delinquent no water shall be run to such shares of stock until all delinquencies are paid.
4. That the zanjeros shall notify each water user when he shall receive the water not less than twenty-four hours beforehand and shall handle the gates and checks in the canal of which he has charge, under the direction of the superintendent.

THE SALT RIVER VALLEY CANALS.

Mr. C. G. Jones, president of the Tempe Irrigating Canal Company, supplies the following description of the methods of water delivery under the canals on the north side of Salt River. These canals are now controlled by the United States Reclamation Service:

The maximum capacity of these four canals when in good condition is 1,000 cubic feet per second and they irrigate 78,500 acres.

The first step necessary after the Government took control was to put the canals in shape and then to adopt some plan of distribution. The first thing was a consolidation of all parallel laterals into one lateral capable of carrying one or more irrigating heads of from 400 to 700 inches, or 10 to 14 cubic feet per second, and to supply these laterals with proper headgates, checks, and measuring devices. Where practicable the Government installed concrete headgates and weirs.

The plan of delivery determined on was to deliver water to irrigators in rotation with a uniform head given to the user for the number of minutes proportional to the number of acres watered. A plan of rotation was so arranged that irrigators should receive water at intervals of from four to eight days and the rotations were begun at the head of each lateral.

A sufficient number of zanjeros has been employed to enable the system to be covered by rides of not to exceed 20 to 30 miles per day for each zanjero. Each

zanjero has to notify each irrigator when he can receive water and how long he is to keep it for each acre. The zanjero performs the duties connected with his work, keeping the superintendent familiar with the conditions of the laterals and canals within his beat.

One of the engineers of the Reclamation Service has control of water delivery. This officer indicates to the zanjeros what size of head to run and for what length of time each irrigator is to receive such head, of course determining this by the supply available. He sees that all measuring devices are accurate, that all laterals are in proper shape to receive water without waste.

Although the Government still retains the practice of the old company of charging for water at a stipulated rate, the system of charging each acre a proportional amount for the actual cost of maintenance and operation will be adopted as soon as the system is in shape.

Uniformity of irrigating heads is merely a matter of the practical handling of water. One irrigator may be able to get along with 100 inches, another with 200 inches, while another may want 500 inches. This can be easily arranged, the difference being made up in the length of time each user receives water.

Under a system of any size it is practically impossible to keep any accurate account of the water without an immense amount of bookkeeping, and this is poor satisfaction to the irrigator.

While for some crops it is hard to use a large head of irrigating water, by a systematic arrangement of the land to be irrigated the disadvantage of a large head can be largely overcome. For instance, a man who has 10 acres in garden and 10 acres in alfalfa can easily divide his irrigating head after it is turned to him, using a small head on his garden and the larger head on his alfalfa. This does not interfere with the canal system or inconvenience his neighbor, and still enables the irrigator to economize in irrigating.

SYSTEMS USED ON CANALS FROM THE HOOD RIVER IN OREGON.

The rich strawberry and orchard lands of Hood River Valley, Oregon, are supplied by two small canals—the Farmers' Irrigating Canal and the East Fork Irrigating Canal—whose delivery systems are worth considering. About 1,500 acres are watered by each.

FARMERS' IRRIGATING CANAL.

This canal has a length of 13 miles and the average flow is about 3,000 miner's inches. Water delivery is in charge of the manager of the company, who receives $4 per day for the time actually employed, amounting to about $150 per year. The direct work of distribution is attended to by three ditch walkers, each of whom receives $65 or $70 per month for five months each year. It is unlawful for any water user to tamper with the laterals in any manner, and the 236 irrigators are required to apply to one of these ditch walkers for any change desired. Few changes are made, the water running continuously as first measured out to users in the spring, except for fluctuations in the flow of the supply from the river. The amount of water usually contracted for by the irrigators is 1 miner's inch per acre,

but as the measuring boxes are only approximately accurate the actual amount delivered varies considerably. A large acreage of strawberries is irrigated under this canal, the strawberries being planted between the trees during the first few years of growth and irrigated each day during the picking season, which lasts usually from May 20 to June 20. The orchards are irrigated at varying intervals, depending upon the views of the individual irrigators. The size of the irrigating head varies with the number of shares held, seldom being less than 5 miner's inches or more than 25 miner's inches. No records of any kind are kept and no office expenses incurred in connection with delivery. The total annual cost of delivery, including the entire salary of the manager and three ditch walkers, is about $1,600.

THE EAST FORK IRRIGATING CANAL.

This canal receives its supply from the East Fork of Hood River. The main canal is 11 miles long, with three main laterals having an aggregate length of 26 miles. In 1908 the company distributed 850 miner's inches at the rate of 1 inch for every 2 acres irrigated. Less water is required under this canal than under the Farmers' Canal, as the land irrigated is devoted almost exclusively to orchards. No accurate measurement is taken of the flow in the main canals or in the laterals, but it sometimes reaches over 1,600 inches, which is the number represented by the shares of stock sold. The by-laws place no limit on the amount of water an irrigator may purchase, but the annual expenses are proportionate to the number of shares held. Each stockholder is expected to make application to the secretary on March 1 of each year, stating the amount of water he expects to use for the ensuing season, and he is charged with that amount upon the books of the company. If he fails to make application he is taxed for the amount represented by the number of shares he holds in the company. The general manager of the company has charge of distribution and receives a salary of $1,000 per year. He devotes his time to the work of maintenance and operation and has under his direct supervision three ditch riders at $50 per month each for five months of each year. Their duties are similar to the duties of the ditch riders employed on the Farmers' Canal, being required to make all changes in the measuring boxes. Each irrigator is entitled to a continuous flow of water, depending upon the number of shares he holds, and in nearly every case a continuous flow is called for.

Under both the Farmers' and the East Fork canals water is measured with miner's-inch boxes with a spillback into the canal to maintain the required pressure. All openings in these boxes are 2 inches in depth and the pressure maintained is 6 inches from the

center of these openings (fig. 7). Accurate measurement is not expected, but the approximate results give entire satisfaction, as the inaccuracies are about equal in all of the boxes.

SYSTEMS USED ON UNITED STATES RECLAMATION SERVICE PROJECTS.

With construction completed and settlement under way on a number of its irrigation projects, the United States Reclamation Service now has before it the many difficult questions of canal management. The task of working out these questions has been assigned to some of the ablest engineers and managers in the Service. Through the

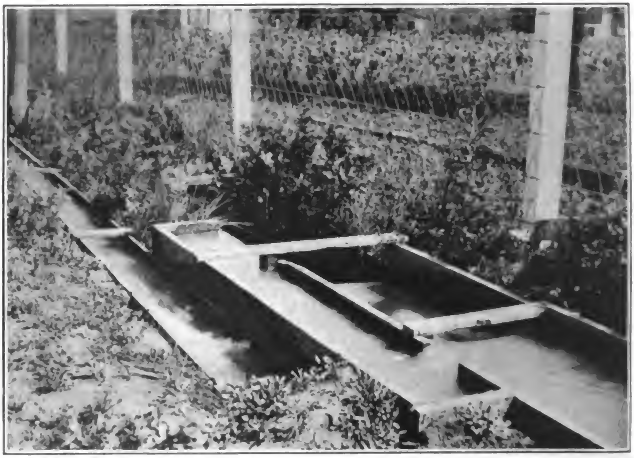

FIG. 7.—"Foote" miner's-inch box used on Hood River Canal.

courtesy of those directly in charge, data on what has thus far been accomplished on its project at Sunnyside, Wash., and the Truckee-Carson project in Nevada, are made a part of this bulletin.

THE SUNNYSIDE PROJECT.

The Sunnyside Canal, formerly owned by the Washington Irrigation Company and later purchased by the United States Reclamation Service, is now operated as a part of its Yakima-Sunnyside project, and from the standpoint of management probably is the most interesting system operated by the Reclamation Service. Its importance has prompted the management to use great care and thorough-

ness in planning its water delivery, on its own account as well as an example to other projects, and more money has been expended probably on this feature of management than would have been justified on a system wholly independent of others. The manager under the former ownership has been retained as manager by the Reclamation Service. Prior to the purchase of the canal by the Government this official had worked out one of the most complete systems of delivery to be found in this country. With his former experience and the means afforded by the funds of the Reclamation Service, he is now in position to accomplish much in the matter of water delivery, both for the Government and for private systems.

The Sunnyside Canal is the largest in Washington. The area irrigated in 1908 was 42,000 acres—9,000 acres in orchards, about 27,000 in timothy, clover, and alfalfa, and the remainder mostly in potatoes. The total length of the main canal is 59.47 miles and the aggregate length of the 225 laterals about 500 miles, the largest being Snipes Mountain lateral, which is 13.5 miles long, carries 90 cubic feet of water per second, and irrigates 6,000 acres. The maximum flow in the main canal is 600 cubic feet per second and the average during the irrigation season 575 cubic feet per second. The manager of the system has charge of canal maintenance and operation as well as of everything connected with the settlement of the project. A competent engineer is employed for the purely engineering work of operation, and an experienced water superintendent has charge of the ordinary canal maintenance and of the direction of the flow in the canal and delivery to the users. There are 12 patrolmen working under the superintendent, patrolling the canal and making deliveries to the users. The superintendent is the only official other than the manager who can authorize a change in the headgates. He spends nearly his entire time in the field supervising the patrolmen, receiving and investigating all complaints, and making written reports to the manager. He also inspects the reports of the patrolmen as sent to the office, makes weekly-service reports to the manager, and special investigations and written reports thereon, as requested from time to time by the manager. Besides these officials, the project has the services of a resident hydrographer, who devotes his entire time to making current-meter ratings at the various rating stations of the system, adjusting lateral weirs, and performing other duties connected with the measurement of water on the system. He and his assistant spend a large part of their time in the field in connection with this work.

The topography of the land within an irrigation project, the character of the soil, and the crops to be irrigated dictate largely the plan of water delivery to be followed. The conditions on the Sunnyside

Canal in the early days led to the supplying of a continuous flow of water to each irrigator, and this has come to be the established system. Almost the entire territory covered by this canal is rolling, and the system of laterals necessary to cover such lands is hardly comparable with the checkerboard system used where the land is comparatively flat. It is necessary for the laterals to be taken from the main canal along the highest ridges in order to water both sides of these ridges, as depressions of 50 feet or more lie between the ridges in some cases. It is practically out of the question to use a head of as much as a single cubic foot per second on such light and rolling land as that under the Sunnyside project, while on level land a stream of 1, 2, or even 3 cubic feet per second is almost essential for economical irrigation. Consequently the use of furrows as distributaries has come to be general under the system. While water is now delivered in a continuous flow from the entire Sunnyside Canal, it is not at all unlikely that time rotation will be adopted under a portion of the system. If it is adopted, it will be because careful experiment has proved it suitable and economical.

PLAN OF DELIVERY.

In organizing the Sunnyside project for water delivery the manager established 12 divisions or beats, for each of which a patrolman is provided. These patrolmen answer by telephone the first call from the manager's office at Zillah at 6 o'clock every morning and report the amount of water entering their respective beats. They are supposed to be out on their beats at 7 o'clock, and between 9 and 10.30 a. m. they are required to give a second report to the office, stating the sizes of all the streams being diverted from the main canal within their respective beats. This report shows the office at Zillah that the patrolmen have covered the main canal. During the remainder of the day their duties are on the laterals. They are expected to follow a regular routine and be at any point on the system at the same time each day. They travel on horseback and carry shovels, empty sacks for use in stopping breaks, poisoned wheat for killing sage rats, and poisoned raisins for killing gophers. The manager believes the patrolmen are in better position to see the condition of the canal and laterals if riding on horseback than if riding in a cart or buggy.

During the season of 1908 the patrolmen read 237 weirs daily, exclusive of the 2,500 or more weirs or miner's-inch boxes at the heads of the farmers' laterals. The manager believes that eventually it may be possible to organize the system so that the duties of the patrolmen will end with measuring the water into the laterals and to organize the irrigators under the various laterals into associations to divide the water among themselves. Such an organization would coincide

with the manager's idea that eventually a continuous flow may be maintained in each lateral and rotation practiced among the users. In 1908 he made deliveries on five laterals with a view to working out a scheme by which the deliveries could be made by the farmers themselves, and also kept complete records of seepage measurement taken twice daily on these laterals to learn the loss that would have to be accounted for after the water was diverted from the main canal.

Close adherence to all of the rules and strict compliance with routine duties are made features of water delivery by the manager. At the beginning of each season and at intervals during it he gives written instructions and comments upon the conduct of the system to the patrolmen, who are provided with ample means for carrying them out and held to the letter of their instructions. Each is given a diary, substantially bound, with a full page for each day of the irrigation season, in which he is expected to keep a complete account of his work for each day. On the inside of the front cover provision is made for slipping a blank for entering the flow in the main canal and at each main lateral for every day of the week, new forms being provided each week and the completed forms filed in the office of the manager. Each patrolman is also provided with two weir tables, one being for use on land which holds what is called the Washington irrigation water right, issued by Washington Irrigation Company prior to the purchase of the system by the Reclamation Service, each right being for not to exceed 1 cubic foot per second for each 160 acres irrigated; the other provides for water rights issued by the Reclamation Service, which are not to exceed 3 acre-feet per acre per year. These tables show the number of cubic feet per second to be delivered for the various sized holdings from 3 to 640 acres, and the depth over weir crests necessary to get such a flow. This depth has been expressed in feet and inches, but it is the intention of the manager to substitute feet and tenths. The depth on weir crests is shown for the three sizes of weirs used in making individual deliveries, namely, 6 inches, 1 foot, and 2 feet. The following are copies of the weir tables used:

Weir table used by patrolmen on the Sunnyside project for Washington Irrigation Company water rights.

[Allowance 1 cubic foot per second to each 160 acres.]

Acres.	Contract quantity.			
	Cubic feet per second.	Depth on weir.		
		6-inch weir.	1-foot weir.	2-foot weir.
		Inches.	*Inches.*	*Inches.*
3	0.018	[illegible]	[illegible]	[illegible]
4	.025	[illegible]	[illegible]	[illegible]
5	.031	[illegible]	[illegible]	[illegible]
7	.043	1	[illegible]	[illegible]
10	.062	1[illegible]	[illegible]	[illegible]
12	.075	1[illegible]	1	[illegible]
15	.094	1[illegible]	1[illegible]	[illegible]
18	.112	2	1[illegible]	[illegible]
20	.125	2[illegible]	1[illegible]	[illegible]
25	.156	....	1[illegible]	1
30	.187	....	1[illegible]	1[illegible]
35	.219	....	1[illegible]	1[illegible]
40	.250	....	2[illegible]	1[illegible]
45	.281	....	2[illegible]	1[illegible]
50	.312	....	2[illegible]	1[illegible]
60	.375	....	2[illegible]	1[illegible]
80	.500	....	3[illegible]	2[illegible]
100	.625	....	4	2[illegible]
120	.750	....	4[illegible]	2[illegible]
160	1.000	....	5[illegible]	3[illegible]
200	1.250	....	6[illegible]	4
240	1.500	....	7[illegible]	4[illegible]
320	2.000	....	8[illegible]	5[illegible]
400	2.500	....	10	6[illegible]
480	3.000	....	11[illegible]	7[illegible]
640	4.000	....	13[illegible]	8[illegible]

Weir table used by patrolmen on the Sunnyside project for Reclamation Service water rights.

[Allowance, 3 acre-feet per acre.]

Acres.	Quantity.			
	Cubic feet per second.	Depth on weir.		
		6-inch weir.	1-foot weir.	2-foot weir.
		Inches.	*Inches.*	*Inches.*
3	0.022	[illegible]	[illegible]	[illegible]
4	.029	[illegible]	[illegible]	[illegible]
5	.036	[illegible]	[illegible]	[illegible]
7	.050	1[illegible]	[illegible]	[illegible]
10	.072	1[illegible]	[illegible]	[illegible]
12	.086	1[illegible]	1	[illegible]
15	.108	2	1[illegible]	[illegible]
18	.130	2[illegible]	1[illegible]	[illegible]
20	.144	2[illegible]	1[illegible]	[illegible]
25	.180	....	1[illegible]	1[illegible]
30	.216	....	1[illegible]	1[illegible]
35	.252	....	2[illegible]	1[illegible]
40	.289	....	2[illegible]	1[illegible]
45	.325	....	2[illegible]	1[illegible]
50	.361	....	2[illegible]	1[illegible]
60	.433	....	3	1[illegible]
80	.570	....	3[illegible]	2[illegible]
100	.722	....	4[illegible]	2[illegible]
120	.866	....	4[illegible]	3
160	1.153	....	5[illegible]	3[illegible]
200	1.443	....	6[illegible]	4[illegible]
240	1.731	....	7[illegible]	4[illegible]
320	2.309	....	9[illegible]	5[illegible]
400	2.886	....	10[illegible]	6[illegible]
480	3.464	....	12[illegible]	7[illegible]
640	4.618	....	14[illegible]	9[illegible]

Patrolmen are also provided with plats of their respective beats showing the location of the canal and laterals, and each is given a book showing the name of each user on his beat, with a description of his holding, taken from the contract on file in the office of the project at Zillah, the acreage irrigated, and the number of deliveries to be made on each. Thus the patrolmen may know what each irrigator in their respective beats is entitled to receive, and it is their duty to see that he receives it.

The devices for water measurement on the Sunnyside system are as complete as the other means for delivery. Measurements are made on the main canal at its head and at the upper end of each beat by means of rated sections of the canal. These sections have been selected where the channel provides the most satisfactory conditions for measurements, and are rated at short intervals by the resident hydrographer. There is also a rating station in each wasteway and at the heads of the three largest laterals. Gage rods have been installed at all of the rating stations.

In the upper beat known as No. 1 and part of No. 2, comprising about 3,200 acres, water is measured through miner's-inch boxes in accordance with the early water-right contracts made a number of years prior to the acquirement of the canal by the Reclamation Service. These boxes have openings 2 inches high with spillways opposite the openings high enough to maintain a 6-inch head over the tops of the openings. Throughout the rest of the system carefully constructed Cipolletti weirs are installed at the heads of the laterals and also at each point of delivery to irrigators. While the Reclamation Service constructs and maintains only the laterals having a capacity of 20 cubic feet per second or more, it places and maintains all the weirs. The 1-foot weirs are built at a total cost of about $12 each, and the others in proportion. Each lateral is numbered according to its distance from the head of the canal, the number of the lateral indicating the distance in miles.

The weirs on the laterals are numbered consecutively, beginning with 1 at the head of each lateral. Figure 8 shows the Cipolletti weir at the head of one of the laterals near Zillah and figure 9 weir No. 2 on the same lateral, with the division box and regulating gate connected with it. The weirs are located carefully in order to get the essential conditions for accurate measurement, the crests and sides being covered with zinc so as to give the sharp edge required for accuracy. The headgates on the laterals and gates at the farmers' weirs are kept locked, and no one has a key except the officers connected with water delivery and measurement. The crests of the weirs at the heads of the laterals vary in length from 1 foot to 9 feet and the crests in the individual weirs have lengths of 6 inches to 2 feet.

RECORDS.

No other system visited in connection with the investigation on which this bulletin is based was provided with such complete forms for keeping records as the Sunnyside Canal. Each patrolman is provided with a diary for noting work done, plat of his beat, list of irrigators in his beat, with area and location of each holding, weir tables, and form for weekly report of water run. As the weir tables show the amount of water due each sized holding, the patrolmen have merely to maintain such an amount flowing over the weirs, a comparatively simple matter after the gates are set and locked.

FIG. 8.—Cipolletti weir at head of lateral on Sunnyside project.

These daily records do not include the amount run to each irrigator, but rather the amount run through each headgate or "heading" lateral leading from the main canal. After the patrolmen have entered on their weekly report cards the amount of water passing each gaging station and into each lateral in their respective beats, the records are telephoned to the office at Zillah and entered on a large sheet by the recording clerk. There is a sheet for each day, on which space is provided for an entry of the flow at the upper and lower ends of each beat and the time of day of the gagings by the patrolmen, also similar data from each lateral leading from the main canal, there being columns to show the number and size of each weir and the nor-

mal depth over its crest. The amounts carried by the various laterals are totaled and entry made of the amount of water actually used, the amount wasted, and the seepage and evaporation losses. The difference between the water entering each beat and the water delivered over laterals or wasted at the lower ends of the laterals is entered under the head of seepage and evaporation losses, thus absorbing any errors of measurement. Under the Truckee-Carson project in Nevada, these losses are classed by the more accurate term of "invisible losses." From the daily report sheets the recording

FIG. 9.—Weir diversion box and regulating gate on the Sunnyside project.

clerk makes up daily, weekly, and monthly summaries, all substantially in the same form, and these furnish a complete record of water delivery for the monthly report of the manager to the Director of the Reclamation Service at Washington. The manager of the project also receives weekly reports from the head of each department working under him. The form for the daily summary is given on page 76.

Form used by the Reclamation Service for daily water summary on the Sunnyside project.

DEPARTMENT OF THE INTERIOR,
UNITED STATES RECLAMATION SERVICE,
SUNNYSIDE OPERATING DEPARTMENT.

DAILY WATER SUMMARY.

Beat No.	Name of patrolman.	Station mile No.	Gage height.	Time.	C. F. S.	Water used.	Water turned over weirs.	Zillah waste-way.	Sunnyside wasteway.	Prosser waste-way.	Loss, seepage, and evaporation.	Total acre-feet.	Acres watered.	Acre-feet per acre.	Remarks.
1		0 8													
2		8 17													
3		17 25													
4		25 30													
5		30 38													
6		38 42													
7		42 48													
8		48 52													
9		52 56													
10		0 3													
11		3 9													
12		0 3													
	Total														

THE TRUCKEE-CARSON PROJECT.

The Truckee-Carson project, the first of the reclamation projects to be opened to settlement, is located in the Carson Sink Valley in western Nevada, and as at present completed covers 100,000 acres of agricultural land thrown open to settlement in 1906. Water was delivered to 225 irrigators in the spring of 1908, and in June following 322 had applied for water, of which 100 were owners of private lands which share the privileges of the project under an agreement with the Reclamation Service. The remaining applicants were homesteaders on the government land of the project, the area homesteaded by them being about 25,000 acres. The principal crop is alfalfa, although the largest area actually watered up to the present time has been pasture.

The plan of water delivery on any project must be developed through experience, and the system now in force in this valley may be changed when more of the land is irrigated. The present system has been worked out with a good deal of care and detail, and offers many valuable suggestions, even though it may be abandoned later for some other system.

When the Truckee-Carson project was thrown open to settlement the canals and laterals had been built to cover practically the entire 100,000 acres. These canals and laterals have an approximate length of 500 miles, of which 85 miles is main canals, 290 miles principal laterals, and 125 miles drain channels. The engineer in charge at the outset was confronted with a stupendous task, for the delivery of water through so many miles of canal to settlers scattered over 100,000 acres was almost impossible. This task was lessened somewhat by restricting the areas open to settlement to a relatively compact area in the general vicinity of the new town of Fallon, which is the center of the project. The maximum amount of water taken into the main canal at the Carson Dam has thus far been 625 cubic feet per second. By August 15 this falls to 400 cubic feet per second, and by November 1 the water is turned out of the canal. Each irrigator under his contract with the Reclamation Service is entitled to 3 acre-feet of water per acre per year. The plan so far, however, has been to allow each irrigator to have water practically on demand for twenty-four hours or some multiple of that time, but it is expected that eventually the stipulation of 3 acre-feet per acre will be strictly adhered to. In fact, the project engineer desires to make such limit at the earliest possible moment, even if there is more water available than will be required for supplying that amount, his idea being that it is highly desirable to restrict the use of water to the actual needs. When the canals and laterals on the project were constructed it was planned that the canal and its branches should contain water continuously throughout the season; that the primary and secondary laterals should carry water for twenty days each month; and that the tertiary laterals should carry water for ten days each month. Whether this plan will be adopted eventually must be determined by experience.

PLAN OF DELIVERY.

The project engineer has organized rather extensive plans for water delivery, and gives his personal attention to the details of delivery as far as possible in connection with his other duties. Under him is a watermaster, who has an office at headquarters and telephone connection with all points on the project. One assistant works in the office or in the field as required. Under the watermaster are 15 ditch tenders and 2 gate tenders, all of whom usually start at a salary of $75 per month, and if satisfactory are raised to $85 per month in the course of three or four months. This entire force is kept under strict discipline and regular hours. Instructions have been printed and each employee is required to comply with them in every particular. The project engineer felt very reticent at first about issuing any printed instructions, knowing that on such a large project it would be necessary to change details constantly so as to comply with

emergencies, but he found it desirable to issue such instructions during 1908, although he expects to revise them from time to time to suit conditions. These instructions are printed and bound and are intended to be carried by the operation employees. Such of these instructions as are specially pertinent to this bulletin are printed below.

Instructions for operation employees.

OPERATION.

(1) *Length of irrigating season.*—The irrigating season of the Truckee-Carson project extends from April 1 to October 31. Water will not be delivered at any other season of the year except on instructions from the watermaster.

(3) *Distribution.*—Accommodation should be ever in the minds of the tenders, but the regulations and welfare of the service should be first in all things.

(*a*) Water is not to be delivered for other than irrigating purposes except by special permission from the project engineer.

(*b*) The distribution of water is the most important of the duties of the ditch tenders, and the accuracy and satisfaction with which this work is done is dependent to a great extent on the regularity of the water flow in the canals at the dams. Gate tenders must keep the water flow in the canals uniform. The alarms should be tested every morning and evening to see that they work perfectly, and if in such condition as to require repairs, notify the watermaster at once. Take water from the main canals into the primary laterals through submerged opening. This will keep the amount of water in the lateral more uniform than by taking it over weirs. Keep this opening free from weeds, etc.

(*c*) Water users must give twenty-four hours' notice when water is required. They should state the amount of water and the length of run desired. Ditch tenders will deliver water as soon as possible after notice. Unless twenty-four hours' notice is given, water will be turned off at the time stated in the original request for water.

(*d*) Ditch tenders only shall operate any gate or turn-out on the project. All gates will be locked as soon as possible to prevent any unauthorized person from raising or lowering them.

(*e*) Water entering any farm must be cared for by the owner throughout the period of the run. The head must not be lowered at night. Farmers must care for water both day and night.

(*f*) Drainage ditches must not be used as waste ditches except in cases of emergency. Waste water must be cared for on the farm, and if waste water in any quantity runs off of it, the amount of water turned into the farm should be lessened accordingly by the ditch tender. Any damage made by waste water entering drains must be repaired immediately by the persons responsible for the damage. Ditch tenders should notify the office of such damage. Failure to repair damage of this sort will result in water being refused for the farm until such damage is repaired.

(*g*) The high-water line will be painted on all the structures on the project, and until this is done refer to the watermaster or project engineer for information as to the high-water line on the different ditches. Never under any conditions is the water to be raised above the high-water line.

(*h*) Regulate velocity to prevent cutting of banks. The velocity may be reduced by checking up the water from the structure below. Keep the water always at the height desired when delivering water for irrigating. Gophers are not apt to work below the water line in a ditch bank.

4. *Reports.*—Keep an exact record of water handled and forward it to the Fallon office each day. Use "water report" cards to show the exact amount of water flowing.

(*a*) Telephone reports must be made by ditch and gate tenders at such times as designated by the watermaster. At least one report must be made daily. Gage readings should be taken so as to be ready in time for these telephone reports. If the ditch tender expects to be absent at report time, previous arrangement should be made with the watermaster. In case of failure to make a daily report the ditch or gate tender will be docked one day's time, unless reasonable excuse for such failure can be made.

(*b*) Ditch and gate tenders will report in writing on the 25th of each month to the project engineer. They should report:

I. Breaks in ditches or other trouble necessitating delays in delivery of water.
  (*a*) Cause of trouble.
  (*b*) Time water was turned off.
  (*c*) Time water was turned on after repairs.
  (*d*) Damage to adjoining land caused by break.
  (*e*) Possible damage to lands by delay in delivering water.
  (*f*) Amount of work to repair break.
II. Extermination of rodents.
III. Miscellaneous topics of interest.

(*c*) Time cards must be filled out by each man, showing character of work done every day. These cards are to be sent in at the end of each month.

(*d*) The agricultural census will be taken once a year, probably at the end of the irrigating season. Instructions will be sent with the blanks at that time. Keep familiar with the progress and success in farming on each farm during the summer. This will make the work at census-taking time much lighter.

(*e*) At census-taking time and again about the 1st of May there will be a homestead inspection. Constant observation in your daily trips will help greatly in this work.

5. *General work.*—Establish a regular route over your district and endeavor to visit each take-out at the same time every day. Occasionally reverse your trip, so as to find out if the gates and take-outs are as you left them. In this way you will be more apt to catch the water thief.

(*a*) In case of a break on any of the government ditches, report immediately to the central office by telephone and also by written report.

(*b*) When riding along a telephone line belonging to the service watch for trouble. Broken guy-wires or braces should be reported, and if breaks are found in the lines, make repairs immediately.

(*c*) Keep tumble weeds and other loose material out of the ditches and drains. When allowed to remain débris accumulates, the current is diverted, and washing and filling of ditch result. Keep flashboards piled up in an orderly manner, and see that each structure is supplied with them. Allow no rubbish to accumulate about your house or around the structures. The neat and orderly manner in which a ditch rider conducts his work becomes a qualification as to his fitness for the position he holds. Carelessness and negligence will not be tolerated.

(*d*) Inspect all structures, bridges, drops, and take-outs, both timber and concrete, at least once a day or as often as passed. Report immediately all repairs needed.

(*e*) All rising weirs and gate-stands should be well oiled and in condition to work easily.

(*f*) Bridges have been provided at convenient places, and canals or drains must not be crossed at other places. Small ditches and drains may be crossed by fording by arrangement with the project engineer. No permission to establish a ford will be given except where physical conditions are such that a ford can be maintained without danger to property of the United States.

(*g*) No bridges, culverts, boxes, fences, or other structures may be built across any canal, lateral, or drain without written permission of the project engineer, and ditch tenders finding such work going on will require that the written permission be shown or the work stopped.

(*h*) Children must be kept out of our ditches and canals unless in company with a responsible adult. Bathing in the large canals is dangerous and all parties should be so warned. Cattle must not be allowed to water in ditches or drains.

The watermaster calls up all ditch tenders at 6.30 o'clock every morning and receives from them the gage readings at the heads of their various beats and delivers to them such orders as he may have regarding the water to be run. When the water becomes scarce it is expected that each ditch tender will be instructed by the watermaster how much water he is to run in each ditch, but at present this is unnecessary. The watermaster calls all the ditch tenders up again at night, if necessary. He remains in his office practically all of the time to receive reports and give instructions to the ditch tenders. It is planned eventually to provide an inspector who will be on the canal and laterals all of the time and will report to the project engineer not only regarding water delivery and canal operation but also regarding maintenance, for which an entirely separate force is maintained. Each ditch tender at present covers an average of 30 miles each day, and he is supposed to go over his entire beat every day if possible, or at least every other day.

MEASUREMENTS.

The project engineer has no doubt whatever regarding the value of water measurements and he takes many of them and keeps a complete record. The measurements taken are as follows:

1. Gage readings twice a day at the dam at Truckee Lake, at the head of the Truckee canal, and at the Carson dam. These gage readings are telephoned to the watermaster immediately after being taken and are also sent in in writing at the end of each week on cards provided by the Service. The dam at each of these points is made up of a series of gates and the record taken by the gate tender and sent to the office shows the number of these gates that are open at each time of measurement, the distance each gate is opened, and the head of water above each gate; the discharge in cubic feet per second is then added at the office from rating tables based on current meter observations.

2. Measurements in the main canal directly above the head of each primary lateral. These measurements are made once a day only and are immediately telephoned to the watermaster, who enters them on specially prepared record sheets in his office. This record is also sent to the office each day on a card, each ditch tender reporting the measurements in his particular district; that

is, the canal or lateral which he covers, the amount of water he receives in cubic feet per second, the point of measurement, the amount of water passed on to the district below, the amount distributed, and the amount wasted.

3. Measurements at each point of delivery to irrigators.—The record of these measurements is sent in daily on a daily report card which shows the name of each user to whom water is supplied, the time it was turned in to him, the time it was shut off, the amount delivered in cubic feet per second and in acre-feet. The latter amount is computed in the office of the watermaster.

The structures on the Truckee-Carson project were designed with the idea of delivering water to all laterals and to farmers over ordinary flashboard gates, and the plan of measurement adopted has necessarily had to conform to them. Rule No. 9 of the instructions to operation employees already referred to covers the matter of measurement as follows:

9. Measurements of water.—The measurement of water passing through the irrigation canals of the Truckee-Carson project is an important duty of the ditch and gate tenders. The amount of water delivered to each farm should be accurately known in order to determine how much water is being used. The water rights sold by the Reclamation Service will call for a definite amount of water per acre of land, the water to be measured at the turnout to the farm.

For the convenience of the ditch tenders the following set of tables have been calculated, in order that the proper measurements can be made under the various conditions existing.

Four different kinds of measurement are likely to be made:

(*a*) Measurement of water over weir when curtain of water falls free.

(*b*) Measurement of water through opening under pressure, the water falling free below.

(*c*) Measurement of water through opening under pressure, the opening being submerged.

(*d*) Measurement of water over weir submerged.

While it is not possible to make accurate measurements through or over the flashboards under the conditions present, the results are amply satisfactory while water is plentiful. The engineer finds that he gets the best results by measuring through submerged openings or openings under pressure, and follows this plan wherever possible.

RECORDS.

The records of the water measurements made are no more complete than the records of water delivery kept in the office of the watermaster at Fallon. The watermaster keeps a log book, into which he enters all telephonic reports of gate tenders and ditch tenders. He also receives, checks, and files the daily reports of the ditch tenders, showing the amount of water received, delivered, wasted, and passed on by them, as well as the daily reports of all of the water distributed to irrigators. From these he makes up a journal, showing the amount of water delivered to each irrigator each day of the month, the total amount distributed, the total amount wasted, the "invisible loss," the water passed on, the total water accounted for, and the total received.

The last two items show the extent of the inaccuracy in the measurements. The invisible loss is intended to cover seepage and evaporation losses and the inaccuracies in measurement. Each sheet in the journal is sufficient to show the total deliveries by one ditch tender for one month, by which it is possible to determine at the end of the year the approximate amount of water each irrigator has received. The record is valuable both for settling controversies with irrigators and for showing the approximate duty of water on the project, and although daily report cards are kept this journal is the complete working record of the office, and great care is taken to make it complete and accurate.

It was not practicable to ascertain the exact cost of water delivery on this project. The force concerned with water delivery is charged also with the duty of keeping careful watch of the system, maintaining an unobstructed flow in the canals and laterals, attending to all ordinary repairs of ditch banks and telephone lines, killing gophers and muskrats, taking the agricultural census, and making homestead applications. These operations cost approximately $18,000 in 1908, which amount included a portion of the salary of the project engineer, but nothing for the large force employed in the maintenance of the canal, and is of little value as a basis for comparison with the cost of delivery on other systems because of the extraordinary conditions found on a large project during the first years of its settlement. In 1908 the annual maintenance charge was 40 cents per acre, but this has proved insufficient and an increase to about 60 cents is being contemplated. This amount is charged for every acre settled whether irrigated or not, beginning with entry on the land or with formal application for water by owners of private lands.

REVIEW AND SUMMARY.

The foregoing descriptions of the plans of delivery should offer many helpful suggestions to the canal manager who has before him the task of arranging or improving a system of water delivery. No discussion of water delivery can be complete that does not consider all canals, because there is hardly a canal that does not have interesting differences from other canals, due largely to differences in the ways men do the same or similar things. It seems possible to outline with some authority certain established principles of delivery that might be followed profitably wholly or in part on most canals, and this is attempted in the following pages.

PLANS OF DELIVERY.

A canal manager has the choice of three general plans, and his choice determines largely his success. Although he should not over-

look local conditions and needs, he can not afford to be too strongly influenced by them and fail to profit by experience elsewhere.

DELIVERY OF CONTINUOUS FLOW.

This plan was adopted at first on a very large majority of the canals in this country, outside of Utah and southern California, and is still used on some canals in nearly every Western State and on most of those in Montana, Wyoming, and other sections situated similarly as to crops, season, water supply, and size of individual holdings. Where the water supply is abundant and the farms as large as 160 acres this plan may give fairly satisfactory results because of the size of stream ordinarily allotted to such an area planted to general crops—say 2 cubic feet per second, which is sufficient to constitute an economical irrigating head. However, where the water supply is restricted, as is the case in nearly every irrigated section in this country, and the farms are small and intensively cultivated, delivery in continuous flow is utterly unsatisfactory from every standpoint. It is wasteful of time and of water, conducive to lax methods of both irrigation and farming, and wholly antagonistic to any system. A notable exception to this is the Sunnyside Canal in Washington, where the use of small irrigation heads run in small furrows is desirable owing to the rolling land and the texture of the soil. Delivery in continuous flow from this canal has been well developed and is attended with the best results, yet it is to be noted that the manager is looking forward to modifying the plan.

DELIVERY IN TURNS OR ROTATION.

In its simplest form this plan of delivery had its origin among the cooperative Mormon communities of Utah, where the water flowing in a ditch or canal was prorated originally on the basis of the acreage irrigated, each acre receiving the entire stream carried or some definite proportion of it for some agreed period of time. With the modifications made necessary by the more complex conditions of larger canals and more diversified products, this is the most generally accepted, and in nearly every way the most satisfactory, plan now in use. It is practiced throughout Utah, wholly or in part on the best canals of Colorado and California, almost entirely in Arizona and New Mexico, on some of the best canals in Idaho, and in fact on all canals, with few exceptions, where any pretense is made to follow the best practice. The exceptions are such canals as the North Poudre and the Consolidated Home Supply in Colorado, the Riverside Water Company's canal in California, and the Northern Canal, in New Mexico, on each of which water is

delivered practically on demand up to the limit of the total seasonal supply.

The essential feature of rotation is its economy. The greatest waste in irrigation comes from dribbling through farm laterals and over parched fields streams too small to accomplish much more than moistening the bare surface or equaling the rapid evaporation that occurs under usual field conditions. Heavy unavoidable losses attend attempts to supply all portions of an extensive system with water at the same time. The use of larger heads run for only a portion of the time in one section of the main canal or in one or two of the main laterals, to be run in the other sections or laterals later, does away with losses, lessens the time and the help necessary, and gives far better results to the farmers.

Rotation reduces evaporation and seepage losses in the main canals and laterals by increasing the head and the consequent rate of flow and economizes the time of the irrigators in applying water. It encourages care and promptness in application by the certainty that the supply will cease at a stated time whether or not the field is covered, eliminates the waste of a continuous flow when not in use, and aids greatly in the systematic use and delivery of water. The farmers could not be taught to irrigate under any possible plan of continuous flow with such care and regularity as is done under the carefully arranged schedules under which water is delivered by the East Riverside, the Redlands, and other irrigation systems of southern California, or by the Bear River Canal in Utah. If these schedules are maintained, and they are usually, the farmers feel that they will receive their respective proportions at their regular turns and can make their irrigation plans with definiteness. When definite schedules are followed the work of arranging for irrigators to receive water, or for keeping account of the amounts used, is either wholly eliminated or reduced to a minimum. Another point in favor of rotation is that it gives to the owner of 10 acres an equal opportunity with the owner of 50 acres to secure economical irrigation. Under a system of continuous flow the former, with a stream of about 10 inches, would no doubt be required to spend as many days irrigating his field as the latter, with 50 inches, would take to cover five times that area.

DELIVERY ON DEMAND OR APPLICATION.

This is the plan of delivery on four of the most interesting systems described in this bulletin—the Riverside Water Company, at Riverside, Cal., the North Poudre and the Consolidated Home Supply canals in Colorado, and the Northern Canal in New Mexico; also on the Truckee-Carson project in Nevada, although on the last merely

as a means of transition to a plan of rotation probably to be adopted after closer settlement of the project. This system can be used with advantage where reservoirs are the chief source of supply and the total available supply for the season may be closely estimated and where the land under irrigation is closely settled. The water can be measured as easily and withdrawn as readily by the farmers to whom it is credited as a bank account. They can make their irrigation plans with certainty, knowing in advance how many acres of sugar beets or potatoes can be carried through the dry summer months, and can withhold water from one crop to apply it to another in such manner as to give the best possible results.

THE DELIVERY FORCE.

The force required to attend properly to water delivery depends on the size of the system, the crops to be irrigated, and the plan of delivery adopted. Water is delivered to 12,000 acres, owned by 520 farmers, under the Davis and Weber Counties Canal in Utah, by a force of 4 men, at an annual cost of 10 cents per acre. On the Farmers' Canal in Montana 60 irrigators water 15,000 acres, and there is connected with water delivery, besides the president of the company, who exercises general oversight, only 1 canal walker, employed for two months each year. On the other hand, while less than 9,000 acres is irrigated under the Gage Canal in California, there are employed for water delivery a chief engineer, 2 head zanjeros or ditch tenders, 3 assistant zanjeros, and 3 laborers, besides a superintendent of water sources and 4 men to watch and care for pumping plants, 1 carpenter, 2 men to repair pipe lines, and 6 men to clean the canal; these last-mentioned, however, are not directly connected with actual delivery. This difference in the forces employed on these canals is due to the different plans of delivery followed and the different requirements. In one case water is delivered in continuous flow to holdings averaging 250 acres planted to general farm crops; in the other it is delivered under a modified plan of rotation to highly cultivated citrus groves. The force employed should be intelligent, well trained, tactful, patient, and industrious. On community systems where one of the farmers is chosen for the work, it is almost impossible to avoid claims of partiality and unfairness on the part of the selfish and less scrupulous irrigators. On the larger canals an experienced engineer or manager is needed to exercise general oversight, with a head watermaster or superintendent under him, who spends his entire time in the field coming personally in contact with the water users and directing in detail the work of the ditch tenders or zanjeros. A few large systems make the serious mistake of trying to get along without the head watermaster, expecting the engineer not only to maintain the canal and keep a water supply in it, but also to direct all of the details of

delivery; no system has yet made a success of such an attempt, however, and the few systems on which it has been tried are comparatively new.

A good corps of ditch tenders or zanjeros is another essential, as it is through these men that a canal management comes into contact with the irrigators, and this point of contact is either a source of friction or the direct means of good service. An irrigator expects his share of water when his turn arrives and to have his "head" maintained throughout his turn, and he is naturally dissatisfied if deprived of either. Unfortunately, some irrigators are not averse to appropriating a portion of their neighbor's supply when just a little more will mean saving a valuable crop, and some are suspicious that the ditch tender is dishonest, or that the home districts of some of the directors are being favored at the expense of some less influential persons. To allay such suspicions and to prevent irregularities a ditch tender must be firm and tactful. The best ditch tender is a man who has been an irrigator himself and can appreciate what it means to lose a year's work by failure to get water through another's fault. If measurements are made the ditch tender should be familiar with the units and the simple methods of measurement, and if records of delivery are kept and a regular system followed he must be methodical in his habits and amenable to direction. The Reclamation Service exacts the strictest compliance to its rules by the ditch tenders. On large, private systems the ditch tenders are expected to be ever alert to the interests both of the water users and the company or other organization representing the ownership of the system. Although in controversies good ditch tenders are more likely to be right than the users, yet they are liable to make mistakes, and water users should be prepared to overlook mistakes. Experience is as much a requisite of a good ditch tender as tact, and his pay should be increased with service.

RULES AND REGULATIONS.

Printed rules and regulations, no matter how simple, are desirable helps in water delivery. They are a definite guide and source of authority to ditch tenders as well as a source of information to water users. On some canals rules are made to cover nearly every phase of delivery, on others they contain only general principles, and in incorporated companies they are frequently embodied in the by-laws. It is not practicable to prepare a set of rules that will be applicable to all conditions, but suggestive points can be brought out.

Plan of delivery.—The plan of water delivery actually in force should be stated plainly, so there can be no question concerning it in the minds of the ditch tenders or the irrigators. An impractical plan is frequently outlined in the rules and a different plan followed,

which leads to confusion in the minds of the water users and is likely to cause friction between them and the ditch tenders.

Amount of water allowed.—A rule should be included stating the quantity to which each user is entitled, whether a pro rata of the entire supply, a continuous flow of a certain number of inches per acre, or a definite quantity, as a certain number of acre-feet or 24-hour inches per annum. This rule is included often in the rule governing the plan of delivery.

Duties and powers of superintendent and ditch tenders.—A statement of the duties of these employees should be kept constantly before them and the irrigators, and it is well to have a rule covering these points. The duties of such officers and employees can be defined only in general, as they are meeting emergencies constantly for which there is no precedent. It should be made clear that meddling with headgates will not be tolerated, and that infractions of such a rule will be sufficient ground for shutting off the water supply of the guilty irrigator, either until a fine is paid or until the next turn comes. It may also increase the zeal and efficiency of the less faithful ditch tenders, provided such a rule is in force, if every irrigator knows that the ditch tenders are required to make regular trips over their beats to attend to delivery and to be available for messages from the irrigators.

Applications for water and notices of its delivery.—Most systems require the irrigators to make application for water, sometimes regardless of whether or not a definite delivery schedule is followed. The application is required often to be in writing and to be filed at least three days before delivery. Printed blanks in convenient form should be furnished where written application is required.

Obstructions in canals and rights of way.—It is customary to have a rule prohibiting obstructions of any kind to be placed in the canal or rights of way, except on written permission from the superintendent, and then proper passageways for ditch tenders must be provided.

Waste of water.—There should be a rule prohibiting the waste of water, under penalty of having the supply shut off or reduced by the amount of the waste.

Complaints.—Some systems require all complaints from irrigators to be made in writing within a specified time, say, five days, after the act or negligence complained of has been committed.

Units and methods of measurement.—The unit or units of measurement to be used are important and need to be defined clearly. It is important also that the rules specify and describe the methods of measurement to be followed. These should be understood thoroughly by the ditch tenders, who should be proficient in their use, and should have essential tables furnished them.

Water charges.—Where regular charges for water are made, the rates should be included in the book of rules, as the farmers like to have such data in an available and compact form.

Who are entitled to receive water.—Limitations are frequently placed on those who may receive water, such as ownership of stock, ownership of preferred rights, payment of assessments, and similar conditions, and these limitations should be included in the rules.

RECORDS.

Just as order and system are a part of any commercial, mercantile, or manufacturing business of any consequence, so should they be a part of every well-managed irrigation enterprise. Essential facts regarding operations are as much a matter of record in the one case as in the other, as may be seen from the orderly collection and recording of delivery records kept up by such systems as the Sunnyside, the Larimer County, and the Gage canals. The value of operating data as a basis of successful organization and profitable output is likely to be greater than in the case of a commercial or mercantile concern, because in an irrigation enterprise the same investment of capital will involve interests of greater magnitude and affect more incomes than it will in the commercial or mercantile concern, excepting possibly railroad transportation. The keeping of records on many canals would greatly encourage economy in the use of water among irrigators, lessen the friction between them and the ditch tenders, and lighten the labors of the management.

Records of flow.—Most systems that make any pretense to careful use of water keep daily records of the amount taken into the canal, which is very necessary where several receive their supplies from the same source and especially where water is distributed to the canals under public supervision, as in Colorado, Wyoming, and sections of Utah, Nevada, and some other States. Entirely apart from the value of a record of flow in an irrigation canal or pipe line as a means of establishing and maintaining stream priorities, such a record shows from year to year what can be expected, the extent of enlargement required, or the amount by which the duty of water must be increased if the irrigated area is to be extended, and the extent of waste resulting from bad irrigation practice. Its greatest value, however, is as a basis of delivery to the irrigators, to replace the approximating and estimating now so common. Records of flow in main laterals are not kept ordinarily, but would probably be valuable on systems where each main lateral is a distinct delivery district.

Records of delivery to individual consumers.—Whenever that stage is reached in the life of an irrigation enterprise when the use of water begins to crowd the available supply, it is of great importance that measurements be made and records kept of the water delivered

to individual consumers. The importance of this is not always recognized, as on many large systems such records are not kept, although they would much more than repay the cost of keeping them. Much progress has been made in this matter, however, during the past ten years, brought about largely by changing the basis of delivery and water charges. Capitalistic or corporation canals formerly charged flat acre rates for water, but this plan has been giving way to that of charging for the water actually delivered, which makes delivery measurements and records essential. Either definite delivery schedules are followed, making records of delivery unnecessary, or such records are kept on 19 of the 30 systems, and to a certain extent on several others described in the first part of this bulletin.

FORMS USED AND SUGGESTED.

In describing the various delivery systems detailed reference was made to the record forms in use and copies were given where practicable. These can be made more suggestive, perhaps, by further description.

Record of flow in main canals or laterals.—This form is simple, and practically the same one can be used on all systems. It merely requires spaces for the name of the channel; the point of measurement; the daily gage readings, with the time taken; and the flow as expressed in the unit of measurement used. It is made in convenient book form, or may be prepared for loose-leaf binding, as indicated, or for a card-filing system. Ordinarily the permanent copy would be made out from daily or weekly field reports by ditch tenders. A suggested form is given below:

Form suggested for permanent record of flow in main canals or laterals.

[This margin for binding.]

NAME OF CANAL.

Monthly record of flow in..
at.......................................for month of.........................., 19...
Measurements made by ....

Date.	Time.	Gage reading.		Flow in cubic feet per second.	
		Feet.	Tenths.		
1...........	....	....	....	....	....
2...........	....	....	....	....	....
3...........	....	....	....	....	....
4...........	....	....	....	....	....
Etc., to 31...	....	....	....	....	....

Record of flow in canals and main laterals at all points.—It may be desirable on large systems to keep a record of all measurements made on the main canal and main laterals, exclusive of measurements directly to consumers. Such a record is kept on the Sunnyside and the

Truckee-Carson projects and is found to be extremely valuable, and might be used with profit on all systems where the flow in both the main canal and the main laterals is measured. The sheet required for such a record is necessarily large, 16 by 34 inches being the size used on the Sunnyside project. If the sheets are bound in book form the size of the book may be reduced by having the form cover opposite pages. The form in use on the Sunnyside project is suggested here, arranged for loose-leaf binding. It can be filled out only from daily or weekly reports from ditch tenders, being too bulky for field use. A suggested form is shown below:

Form suggested for permanent record of flow at all points of measurement on main canals and laterals.

[Size 16 inches by 34 inches.]

[This margin for binding.]

NAME OF CANAL.

Daily record of flow in main canal and laterals for month of ...., 190..

Main canal.

Points of measurement.	1	2	3	4	30	31	Average for month. Cubic feet per second.	Total for month. Vertical depth in feet.

Laterals.

Laterals and points of measurement.	Areas irrigated, in acres.	1	2	3	4	30	31	Average for month. Cubic feet per second.	Total for month. Vertical depth in feet.
Totals, cu. ft. sec.									
Lost or not diverted, cubic feet per second									

Daily or weekly reports of flow in ditches.—Perhaps the most convenient shape for weekly reports of flow in main canals or laterals is a card the size of a postal card, with the form printed on one side, similar to those used by the United States Department of Agriculture.

the United States Geological Survey, and some canals. Daily reports are seldom made except by telephone, but a similar form would of course answer for them also. A suggested form for keeping such reports follows:

Form suggested for weekly report of flow of water in main canals or laterals.

NAME OF CANAL.

Report of water in .... at ...... for week ending ......, 1909.

Day.	Month.	Date.	Time.	Gage reading.		Flow cu. ft. sec.	Remarks.
				Feet.	Tenths.		

(Under "Remarks" mention any unusual condition, as "flood," "break in canal," etc., and state how long water was out of canal and when, if at all. Forward this card promptly at end of week.)

——— ——— *Ditch Tender.*

Ditch tender's diary.—These diaries are not as a rule kept in a form to make them useful, although they are very valuable on some systems. In some cases permanent records are made from scratch notes sent to the canal office, but the scratch book is not kept. The value of these diaries has been determined frequently only when rights have been contested, and there are many instances where a properly kept diary would have satisfactorily settled serious disputes.

An admirable diary is being kept by each patrolman on the Sunnyside Canal and filed carefully in the office at Zillah at the end of the season. It is 5 by 9 inches and contains 232 pages. It is made for use during any season, the pages not being dated, space being provided for the month, day, and year. The binding is of stiff board and canvas to insure preservation. The records of flow in the canals or laterals are not entered in this, but a card 4 by 8 inches to take these records is made to slip under small straps at each of the four corners of the inside front cover. Each card covers one week and they are filled out by the patrolmen as they pass over their beats and at the end of the week sent to the office at Zillah for filing. The points of measurement, with the size of the weir at each, are noted in the left-hand column, seven columns being provided at the right for entering the flow of each day of the week.

Records of delivery to irrigators.—A great variety of forms are in use for keeping records of such delivery to irrigators because of the many conditions under which water is delivered. They include cards, sheets, and books of different forms. One of the simplest card forms is that used on the Truckee-Carson project, of which a copy is repro-

duced below. This card is filled out and sent daily to the project headquarters at Fallon. By using both sides of all of the lines, a record of 40 deliveries can be entered on it.

Form of record of water delivery to irrigators used on Truckee-Carson project, Nevada.

RECORD OF WATER DISTRIBUTED.

Month ______. Date ______, 19__.

User's name.	From (time)—	To (time)—	Second-feet.	Acre-feet.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

...., *Ditch Tender.*

By adding to the above form the crops irrigated, it might be adapted to another system; by eliminating the columns for the quantity of water delivered it would suit a system on which devices for measurement to irrigators have not yet been provided. In using this form the ditch tenders on the Truckee-Carson project designate the hours by 1 to 24, 1 being 1 a. m. and 24 being 12 midnight, thus doing away with the confusion of morning or afternoon.

Books for entering records of individual deliveries are provided on the North Poudre, the Larimer County, the Consolidated Home Supply, the Santa Ana Valley, and the Bear River canals, in addition to the Sunnyside Canal, the various forms of which have been described. The best books for this purpose are of a size to be carried conveniently in the pocket, substantially bound in boards and canvas, and containing the proper columns and headings. The loose-leaf book used on the Bear River Canal is more of a guide to the ditch tenders than a book in which to enter deliveries, as delivery is made according to a definite schedule made up by the chief engineer. For such purpose the loose leaves are convenient on account of the ease with which changes can be entered. For a book to be filled out and kept throughout the season by the ditch tenders the bound book is preferable, because the only valuable record in case of dispute is the original record made by the ditch tenders at the time of delivery, but where the original record is sent to the office as soon as taken, or weekly, or monthly, a book or pad with detachable leaves punched for filing in binders is perhaps the best that can be used. A leaf from such a book, used on one of the California canals, is shown below. Probably no more convenient and compact device could be arranged.

Detachable loose-leaf form for keeping record of deliveries to irrigators on a California canal.

[Space for binding.]

Report of irrigation from......Canal......Div......Co.
Water ordered by...... ....
For account of...... ....
Land irrigated.... | T.... | R.... | Sec........ | Lots............ | Acres............

From gate.	Water turned on.			Water turned off.			Hours flow.	Measurements of openings.			
	Date, 190-.		Hour.	Date.		Hour.		Upper.	Lower.	Depth.	Width.
....	....	....	.... m.	....	....	.... m.	....	....	....	....	....
....	....	....	.... m.	....	....	.... m.	....	....	....	....	....
....	....	....	.... m.	....	....	.... m.	....	....	....	....	....
....	....	....	.... m.	....	....	.... m.	....	....	....	....	....

Crop......Soil......Distance from canal......
Condition of delivery ditch......
...., *Zanjero.*

[Indorsement on back.]

ENGINEER'S MEMORANDUM.

This delivery reduced to terms of second-feet flowing per twenty-four hours.

Total delivery, ______ second-feet.
Average per acre, $______
Total per acre, $______ second-feet, $______
Average per acre, $______

Below are the forms used by the Imperial Water Company No. 5, in Imperial Valley, Cal., for recording individual deliveries, and the form of receipts for water delivered used by the Modesto and Turlock Irrigation districts. The latter are not filed in order, the stubs being preserved, as bound, for use in case of dispute.

Form for keeping record of deliveries to irrigators used by Imperial Water Company No. 5 in California.

IMPERIAL WATER CO. NO. 5.

Delivered to --

Owner ______ ______
Tenant ______ ______
Cert. No. ____. On ______ Sec. ____ Twp. ____ S., R. ____ E. S. B. M.
Month ______
______ Lateral.

Date.	Hour.		Front measurement.	Back measurement.	Depth of opening.	Width of opening.	Over pour measurement.		Second-feet.	Amount.
	Turned on.	Turned off.					Depth.	Width.		
....	....	....	....	....	....	....	....	....	....	$........
....	....	....	....	....	....	....	....	....	....	$........
....	....	....	....	....	....	....	....	....	....	$........
....	....	....	....	....	....	....	....	....	....	$........
....	....	....	....	....	....	....	....	....	....	$........

Total No. hours ____
Received by ______ ______
Delivered by ______ ______

Form of water receipt filled out by ditch tenders and signed by irrigators on the Modesto irrigation district, in California.

WATER RECEIPT.	WATER RECEIPT.
Lat. No. ..... Diverting gate No.	Lat. No. ..... Diverting gate No. .....
Water received:	Water received:
Date	Date ....
Number of hours	Number of hours ....
Acreage	Acreage ....
Crop	Crop ....
Water refused on	Water refused on ....
Date of offer	Date of offer ....
Reason of refusal	Reason of refusal ....
.... *Ditch Tender.* .... *Irrigator.*	.... *Ditch Tender.* .... *Irrigator.*

Form of water receipt filled out by ditch tenders and signed by irrigators on the Turlock irrigation district, in California.

WATER RECEIPT.	WATER RECEIPT.
Lat. No.... Diverting Gate No....	Lat. No.... Diverting Gate No....
Water received:	Water Received:
Date.... Hours.... Acres.... Crop....	Date.... Hours.... Acres.... Crop....
Date.... Hours.... Acres.... Crop....	Date.... Hours.... Acres.... Crop....
Date.... Hours.... Acres.... Crop....	Date.... Hours.... Acres.... Crop....
Date.... Hours.... Acres.... Crop....	Date.... Hours.... Acres.... Crop....
Water refused on......	Water refused on......
Date of offer......	Date of offer......
Reason of refusal............	Reason of refusal............
...., *Irrigator.*	...., *Ditch Tender.*
...., *Ditch Tender.*	...., *Irrigator.*

Water ledgers.—The use of water ledgers or other books for entering records of seasonal or monthly deliveries is a feature of the record keeping on some systems. On the North Poudre, Gage, Consolidated Home Supply, and the Northern canals, and the Truckee-Carson and Sunnyside projects ledgers of various kinds are kept, as hertofore described.

WATER CHARGES.

The amount of water used rather than the number of acres irrigated is now established thoroughly as the wisest and best basis for charging for water. In cooperative or mutual companies such a question does not arise ordinarily, as stock ownership entitles an irrigator to his share of the supply run. Where water is sold to irrigators the question is an important one. Charging for the number of acres irrigated has proved wasteful both to consumers and irrigation companies and unjust to the careful irrigator by requiring him to pay the same amount for the water he uses as his slovenly neighbor pays for twice that amount. Paying for water actually received, and therefore at the same rate for water wasted as for water used, has been found not only to reduce the total amount consumed but also to benefit greatly the land irrigated. It also increases the areas possible to irrigate, benefiting both the individual irrigators and the public. It is unfortunate that this improved irrigation practice can not be applied to the hundreds of irrigation systems on which water is not sold to the irrigators. The same result might be attained, in a measure, by bas-

ing maintenance and operation assessments in cooperative and mutual companies on the water used rather than on the shares of stock owned, as is done on the small canals on Hood River in Oregon, provided such an arrangement could be made legal. A very convenient method of computing water charges is in use by the Imperial Water Company No. 1, at Imperial, Cal. Under this system the charge is 50 cents per acre-foot, and as 2 acre-feet of water is practically equivalent to 1 cubic foot per second running for twenty-four hours (1.9834 acre-feet), amounts to $1 per cubic foot per second for each twenty-four hours. The flow through a measuring box, expressed in cubic feet per second, becomes therefore the charge for the water by pointing off two decimal places. To render computations in the field unnecessary, tables have been prepared and printed which show at a glance what the charge is under all conditions of measurement. Measurements are made over weirs and through submerged orifices under pressure, and the tables in use apply to weirs up to 48 inches long with a depth over the crest up to 10 inches and to submerged orifices up to the same length and depth, with pressures of 1.5 to 14 inches.

Below is shown a copy of the table used for submerged orifices with a pressure of 6 inches. The left-hand vertical column indicates the height and the top horizontal column the length of the orifice. If the height of the orifice is 5 inches and the length 36 inches, the charge is found in the column headed 36 and to the right of 5, which is $4.41:

Table used for computing charge for water through orifices under 6-inch pressure on Imperial Canal No. 1.

Height of the orifice in inches.	Length of orifice in inches.														
	30.	32.	33.	34.	35.	35½.	36.	37.	38.	39.	40.	42.	44.	46.	48.
1	73	78	81	83	86	87	88	91	93	96	98	103	108	113	118
1½	110	118	121	125	129	130	132	136	140	143	147	154	162	169	176
2	147	157	162	167	171	173	176	181	186	191	196	206	216	225	235
2½	184	196	202	208	214	217	220	227	233	239	245	257	269	282	294
3	220	235	243	250	257	261	265	272	279	287	294	309	323	338	353
3½	257	274	283	292	300	304	309	317	326	334	343	360	377	394	412
4	294	314	323	333	343	348	353	363	372	382	392	412	431	451	470
4½	321	353	364	375	386	391	397	408	419	430	441	463	485	507	529
5	367	392	404	416	429	435	441	453	465	478	490	514	539	563	588
5½	404	431	445	458	472	478	485	499	512	526	539	566	593	620	647
6	441	470	485	500	514	521	529	544	559	573	588	617	647	676	706
6½	478	510	526	541	558	565	573	589	605	621	637	667	701	733	764
7	514	549	566	583	600	608	617	635	652	669	686	720	755	789	823
7½	551	588	606	625	643	652	661	680	698	716	735	772	808	845	882
8	588	627	647	666	686	696	706	725	745	764	784	823	862	902	940
8½	625	666	687	708	729	739	750	771	791	812	833	875	916	958	1,000
9	661	706	728	750	772	783	794	816	838	860	882	926	970	1,014	1,058
9½	698	745	768	791	815	826	838	861	884	908	931	978	1,024	1,071	1,117
10	735	784	808	833	857	868	882	906	931	955	980	1,029	1,078	1,127	1,176

COST OF WATER DELIVERY.

Below are given copies of two tables summarizing the cost of water delivery on some of the typical systems described. The first table relates to canals or companies for which the delivery costs obtained include deliveries to individuals; the second one relates to systems for

which the delivery costs include delivery to laterals only, delivery on the laterals being left to the irrigators. In the former case the average annual cost per acre is 41½ cents; in the latter case it is only 7½ cents. The larger costs on some of the California systems in the first table are due to the larger number of irrigators and the smaller holdings under them, the latter averaging under 8 acres on the Redlands system, while the average holding on the Consolidated Home Supply Canal is nearly 154 acres. In the second table the low cost on the Farmers' Canal results from the short irrigation season of only two months and from the facts that the crops grown are principally grain, clover, and alfalfa, and that the average holding is 250 acres.

Annual cost of water delivery per acre on 13 typical systems where cost includes delivery to individuals.

Company or system.	Cost per acre.
Gage Canal Company, California	$0.54
East Riverside Water Company, California	.95
Riverside Water Company, California	.78
Redlands Water Company, California	1.30
Azusa Irrigating Company, California	.48
Modesto Irrigation District, California	.40
North Poudre Canal, Colorado	.16
Consolidated Home Supply Canal, Colorado	.15
Bear River Canal, Utah	.16
South Jordan Canal, Utah	.15
Utah and Salt Lake Canal, Utah	.09
Northern Canal, New Mexico	.15
Tempe Canal, Arizona	.14
Average	.41½

Annual cost of water delivery per acre on 4 typical canals where cost includes delivery to the laterals only.

Company or system.	Cost per acre.
Rockyford Canal, Colorado	$0.08
Wheatland Canal, Wyoming	.11
Farmers' Canal, Montana	.01½
Davis and Weber Counties Canal, Utah	.10
Average	.07½

LATERAL ORGANIZATIONS.

A question arising in the consideration of the plan of water delivery for some irrigation systems is the separate organization of those receiving water from the same lateral, which is often desirable because of the resulting economy and simplicity of management. Irrigators like to be in close touch with the one in charge of distributing water to them, and there is always dissatisfaction when they are not. On large systems the superintendent is likely to be so busy that he seldom gets away from the main canal or the main laterals, leaving the ditch tenders to adjust possible differences with or between the irrigators on the laterals. The farmers would get along

better sometimes if they chose and directed their lateral ditch tenders themselves, as is done on small systems in Utah and elsewhere, as on the South Jordan and the Utah and Salt Lake canals. Again, the affairs of the system might run more smoothly if the duties of the engineer or superintendent end with maintaining the flow in the main canal and in distributing to each lateral its share of the total supply, as is the plan on the Larimer County Canal and numerous other canals in the irrigated sections. On these canals, however, the irrigators on the same laterals are merely working under a general understanding among themselves that one of their number shall see that each receives his proper turn and proper share. On a lateral with 50 or 100 irrigators, however, either a closer agreement is necessary or the company superintendent must have charge. Separate lateral organizations, each with its own directors and ditch riders and treasury, are maintained on the Wheatland Canal, and all business with the laterals, both in maintenance and operation, is transacted by their respective organizations, independently of the main canal company. The general superintendent of the latter is called in only to aid in the settlement of disputes. Contrary to the idea of separate lateral organizations, in the Modesto irrigation district the large private laterals, built to open particular tracts of land and until recently managed independently of the district, have now been taken over by the district at the request of the irrigators, as it is believed that the water will be divided more satisfactorily by the district. On the other hand, the managers of the two Reclamation Service projects already described are looking forward to the time when the users on the separate laterals will be organized for water distribution, and the manager on the Sunnyside project is experimenting already with that end in view.

So far as is known, the most complete lateral organizations thus far effected are those on the Amity Canal in Colorado, which were incorporated separately under the laws of that State. The average acreage under these nine laterals is 2,000 acres. The laterals were built by the Amity Canal Company but were transferred for purposes of maintenance and management to lateral organizations as soon as three settlers had taken up holdings and begun to irrigate, the company retaining the unassigned rights in the laterals pending settlement of the areas under them. This plan of organization is somewhat similar to that of the canals in the Imperial Valley in California, where the California Development Company, pending settlement, controls unsold stock of the different water companies, which are virtually organizations of the large laterals of a larger system. Very complete and efficient lateral organizations are also in operation on canals around Fresno, Cal.

Lateral organizations having complete charge of water delivery are not practicable where water is measured and sold to users at a definite

quantity rate, except on very large systems. Under such conditions there must be some definite authority in control, as there must be a single system of delivery and charges, applied everywhere alike. Where water is prorated and charges assessed annually, however, and the system is too large to enable the superintendent or other officer in charge to supervise delivery personally, such organizations are of much value. They make prorating more easy, increase the interest of the irrigators in the management of the system, thus lessening their antagonism. They lighten the duties of the superintendent and at the same time increase his efficiency in making proper divisions between the laterals and in maintaining the main channels free from breaks and obstructions.

MEASUREMENT OF WATER.

Records of the amount of water delivered to individual consumers become of importance as soon as the use of water begins to crowd the available supply, so that it becomes necessary to limit each irrigator to the amount called for by his contract or his right in the canal. This can be done only by measuring the water run to laterals, on which the flow is prorated on a time basis, or by measuring the water run to individual consumers, and the working out of the practical details of water measurement is one of the most difficult questions of water delivery. Many canals irrigate land nearly as high as the top of the water running in them, making the fall or head so little that the use of measuring devices is impossible. In other canals, where there is sufficient fall or head to use measuring devices, there is often so much fluctuation in the flow that even approximate accuracy can be obtained only by frequent readings of the measuring device or by the use of automatic registers. The latter are impracticable for use on farm laterals, however, because of their cost and the attention and care necessary to keep them working accurately. In an effort to overcome both of these difficulties several engineers are experimenting with original water meters, designed to measure accurately under varying heads with a minimum loss of head, to be capable of direct reading in a definite unit of quantity, and to be constructed and installed at a cost within the reach of irrigators. Until some such device is perfected and made available irrigators must get along with the more or less unsatisfactory devices now in use. Technical descriptions of these may be found in various bulletins, published by this Office and the different agricultural experiment stations, as well as in books on irrigation engineering.[a] It might be stated here, however, that when

[a] Colorado Sta. Bul. 27; Montana Sta. Buls. 34 and 72; Wyoming Sta. Bul. 53; "Special Instructions to Watermasters," state engineer Utah, 1898; U. S. Dept. Agr., Office Expt. Stas. Bul. 86.

the fall will permit, the Cipolletti weir is one of the most satisfactory devices known. As stated in the description of the Sunnyside project, the device is specially valuable where the fluctuation in the canal flow is not great. When the fall is very small and the fluctuation considerable, some form of submerged orifice is most desirable, as it will measure with the least loss of head and with the least inaccuracy under changing head of any device in use.

CONCLUSIONS.

The management of irrigation enterprises is one of the most fruitful subjects of inquiry in the whole field of agricultural economy. The public is interested in it through its desire to see the best economic and business principles applied in the use of one of the country's richest resources. The irrigator is interested in it through the close relation it bears, in the case of his own canal, to his own income. Those seeking employment are interested in it because of the field it offers for a profitable and useful livelihood.

Water delivery is the part of irrigation management that comes in closest touch with the man who is using the water, and is therefore the part in which he is most immediately interested. The superintendent and the ditch tender are the ones who bring him his supply of water, and anything that will help them in perfecting and executing their plan of delivery is of direct benefit to him.

This bulletin presents facts regarding water delivery in the different States and Territories to assist in making the application of the best principles more general. While many delivery systems are admirable and show careful regard for order and efficiency, few, if any, of them are entirely satisfactory to their managers or are the best that will be attained. They offer practical suggestions, however, to any irrigation manager who is arranging a plan of delivery. Especially suggestive are the plans and details that have been worked out in the delivery systems of the best canals in southern California; of such canals as the North Poudre, the Larimer County, and the Consolidated Home Supply canals in northern Colorado; of the Bear River Canal in Utah; of the Northern Canal in New Mexico; and of the projects of the Reclamation Service. On most systems the details in force are original with their superintendents or managers rather than copies of details perfected elsewhere. The central ideas however, have been developed in many sections, sometimes independently of the development of the same ideas elsewhere, sometimes as an outgrowth of what others had done.

O

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON IRRIGATION—Continued.

BULLETINS—continued.

Bul. 192. Irrigation and Drainage Laws of Italy. Translated by R. P. Teele. Pp. 100.
Bul. 201. Cost of Pumping from Wells for the Irrigation of Rice in Louisiana and Arkansas. By W. B. Gregory. Pp. 39.
Bul. 203. Distribution of Water in the Soil in Furrow Irrigation. By R. H. Loughridge. Pp. 63.
Bul. 205. Irrigation in Wyoming. By Clarence T. Johnston. Pp. 60.
Bul. 207. Irrigation in the Sacramento Valley, California. By Samuel Fortier, assisted by O. W. Bryant, J. E. Roadhouse, A. E. Wright, and J. H. Barber. Pp. 99.
Bul. 209. Irrigation in Oregon. By John H. Lewis, assisted by Percy A. Cupper. Pp. 67.
Bul. 210. Irrigation in South Dakota. By Samuel H. Lea. Pp. 60.
Bul. 211. Irrigation in Kansas. By Don H. Bark. Pp. 28.
Bul. 214. Irrigation in the State of Washington. By O. L. Waller. Pp. 64.
Bul. 215. Irrigation in New Mexico. By Vernon L. Sullivan. Pp. 42.
Bul. 216. Irrigation in Idaho. By J. Stephenson, jr. Pp. 59.
*Bul. 217. Drainage of Irrigated Lands in the San Joaquin Valley, California. By S. Fortier and V. M. Cone. Pp. 58.
Bul. 219. Irrigation in North Dakota. By T. R. Atkinson. Pp. 39.
Bul. 222. Irrigation in Texas. By J. C. Nagle. Pp. 92.
Bul. 226. Irrigation Experiments and Investigations in Western Oregon. By A. P. Stover. Pp. 68.

FARMERS' BULLETINS.

Bul. 116. Irrigation in Fruit Growing. By E. J. Wickson. Pp. 48.
Bul. 138. Irrigation in Field and Garden. By E. J. Wickson. Pp. 40.
Bul. 158. How to Build Small Irrigation Ditches. By C. T. Johnston and J. D. Stannard. Pp. 28.
Bul. 263. Practical Information for Beginners in Irrigation. By Samuel Fortier. Pp. 40.
Bul. 277. Use of Alcohol and Gasoline in Farm Engines. By C. E. Lucke and S. M. Woodward. Pp. 40.
Bul. 371. Drainage of Irrigated Lands. By C. F. Brown. Pp. 52.
Bul. 373. Irrigation of Alfalfa. By S. Fortier. Pp. 48.
Bul. 392. Irrigation of Sugar Beets. By F. W. Roeding. Pp. 52.
Bul. 394. The Use of Windmills in Irrigation in the Semiarid West. By P. E. Fuller. Pp. 45.
Bul. 399. Irrigation of Grain. By W. W. McLaughlin. Pp. 25.
Bul. 404. Irrigation of Orchards. By Samuel Fortier. Pp. 36.

CIRCULARS.

*Circ. 48. What the Department of Agriculture is Doing for Irrigation. By Elwood Mead. Pp. 4.
*Circ. 58. Irrigation in the Valley of Lost River, Idaho. By Albert Eugene Wright. Pp. 24.
*Circ. 59. Progress Report of Cooperative Irrigation Investigations in California. By S. Fortier. Pp. 23.
*Circ. 63. Work of the Office of Experiment Stations in Irrigation and Drainage. Pp. 31.
*Circ. 65. Irrigation from Upper Snake River, Idaho. By H. G. Raschbacher. Pp. 16.
*Circ. 67. Investigations of Irrigation Practice in Oregon. By A. P. Stover. Pp. 30.
Circ. 78. Progress Report on Irrigation Experiments in Willamette Valley, Oregon. By A. P. Stover. Pp. 25.
Circ. 92. Progress Report on Experiments in Supplemental Irrigation with Small Water Supplies at Cheyenne and Newcastle, Wyo., 1905–8. By O. W. Bryant. Pp. 51.
Circ. 95. Experiments in Supplemental Irrigation with Small Water Supplies at Cheyenne, Wyo., in 1909. By John H. Gordon. Pp. 11.
Circ. 101. The Selection and Installation of Machinery for Small Pumping Plants. By W. B. Gregory. Pp. 40.

SEPARATES.

*Rise and Future of Irrigation in the United States. By Elwood Mead, Expert in Charge of Irrigation Investigations, Office of Experiment Stations. Pp. 591–612. (Reprint from Yearbook, 1899.)
*Some Typical Reservoirs in the Rocky Mountain States. By Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 415–430. (Reprint from Yearbook, 1901.)
*Preparing Land for Irrigation. By R. P. Teele. Pp. 239–250. (Reprint from Yearbook, 1903.)
*Potato Culture near Greeley, Colo. By J. Max Clark. Pp. 311–322. (Reprint from Yearbook, 1904.)
The Relation of Irrigation to Dry Farming. By Elwood Mead, Chief of Irrigation and Drainage Investigations, Office of Experiment Stations. Pp. 423–438. (Reprint from Yearbook, 1905.)
The Use of Small Water Supplies for Irrigation. By Samuel Fortier, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. 409–424. (Reprint from Yearbook, 1907.)
*The Scope and Purposes of the Irrigation Investigations of the Office of Experiment Stations. By Elwood Mead, Irrigation Expert in Charge. Pp. 317–327. (Reprint from Annual Report of Office of Experiment Stations for 1901.)
*Duty of Water in the Gallatin Valley, Montana. By Samuel Fortier. Pp. 175–196. (Reprint from Bulletin 86 of Office of Experiment Stations.)
*Irrigation in Utah. By R. C. Gemmell and Geo. L. Swendsen. Pp. 197–218. (Reprint from Bulletin 86 of Office of Experiment Stations.)

 [Continued on fourth page of cover.]